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K1P 5V6

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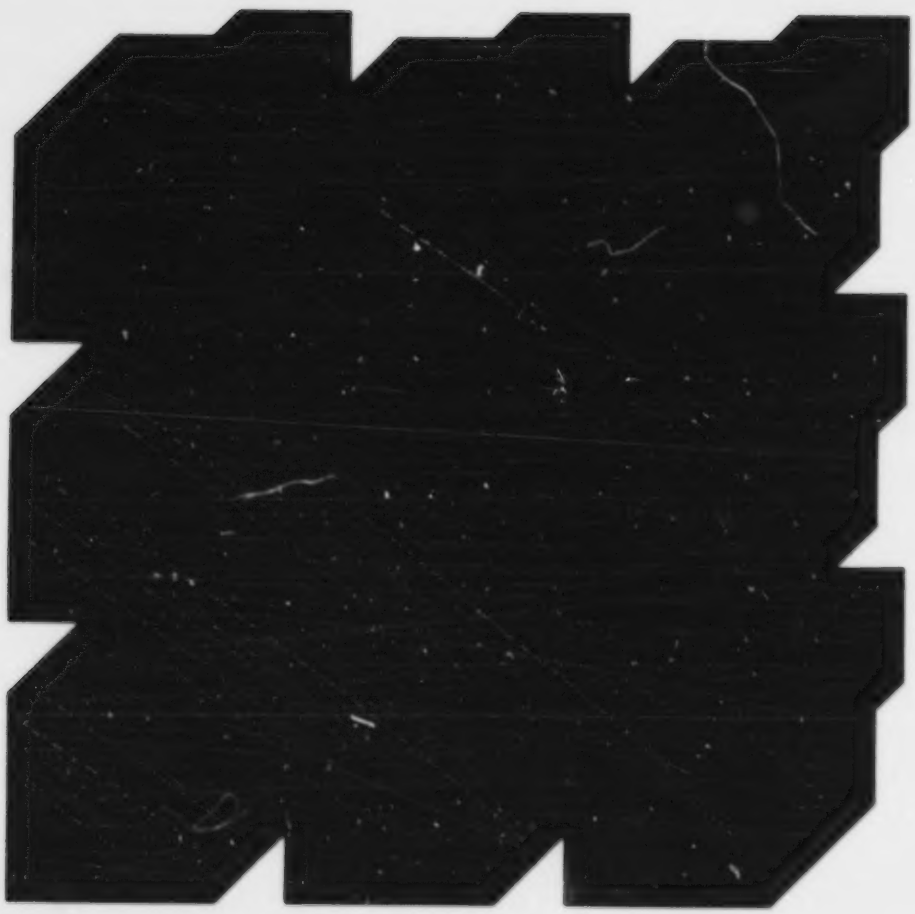

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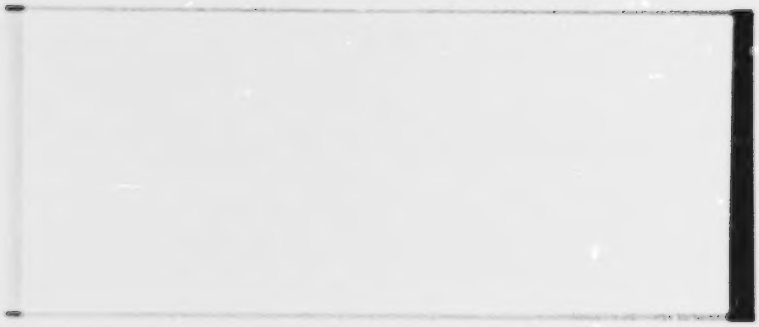

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DISCUSSION PAPER NO. 285

The Organization and Control of Crown Corporations

by M.K. Berkowitz and
Y. Kotowitz

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Council Secretary
Economic Council of Canada
Post Office Box 527
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K1P 5V6

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L'organisation et l'administration
des sociétés de la Couronne

Résumé

Pour déterminer la forme et l'étendue appropriées de la délégation du pouvoir décisionnel au sein des sociétés de la Couronne, il est particulièrement important d'évaluer les objectifs précis de l'entreprise en cause et la nature de l'information à laquelle les personnes concernées, c'est-à-dire, le grand public, le parlement, le ministre responsable et la haute direction de l'entreprise auront vraisemblablement accès, à un coût raisonnable.

En outre, afin de décider de l'étendue de la délégation de pouvoir, il faut tenir compte des coûts occasionnés pour éliminer les informations divergentes. Cette évaluation des coûts servira aussi à définir la nature de la surveillance du rendement, de même que l'ampleur des contrôles prédécisionnels exercés au sein de la société publique.

Deux instruments sont nécessaires à une surveillance efficace du rendement: (a) des moyens de contrôle peu coûteux et à marges d'erreurs restreintes; et (b) des mécanismes efficaces de récompense et de punition. Ces instruments ne sont que des compléments, en ce sens qu'il est peu probable qu'un régime de surveillance dépourvu de récompenses ou de punitions convenables puisse contribuer à inciter la direction à réaliser les objectifs souhaités ou à y consacrer les efforts suffisants. Par ailleurs, des mécanismes de récompense bien conçus peuvent réduire efficacement la surveillance dans la mesure où ils réussissent à éliminer les conflits entre les objectifs de l'organisation et les intérêts des membres de la direction.

La présente étude aborde les problèmes de contrôle des entreprises publiques. Dans ce cadre, elle étudie d'autres formes organisationelles possibles pour l'entreprise publique, ainsi que les problèmes de contrôle qu'elle pose et les méthodes employées pour les résoudre. Elle examine aussi l'applicabilité de ces solutions. L'étude porte également sur les mécanismes de contrôle prédécisionnel et postdécisionnel utilisés en fonction du rendement obtenu et visant à vérifier le comportement des cadres des entreprises publiques. Les difficultés relatives à la sélection des cadres sont également examinées, dans le dessein d'élaborer le meilleur mécanisme d'encouragement possible. En dernier lieu, cette étude se penche sur les méthodes de gestion interne qui ont pour but d'inciter les travailleurs à un rendement maximum.

L'analyse effectuée a donné naissance à bon nombre de recommandations ayant pour objet d'améliorer le contrôle exercé sur les sociétés de la Couronne au Canada.

Recommandation 1: Les objectifs des sociétés de la Couronne devraient être précisés clairement et il faudrait, chaque fois qu'il est possible, élaborer des règles pour en assurer une évaluation impartiale.

Recommandation 2: Le rôle du Vérificateur général à cet égard devrait avoir plus d'ampleur.

Recommandation 3: Le gouvernement ne devrait pas se porter garant des dettes des sociétés de la Couronne.

Recommandation 4: La nomination des cadres supérieurs des sociétés de la Couronne devrait se faire en deux étapes: un comité consultatif du secteur privé devrait soumettre une liste de candidats compétents à un comité parlementaire qui sélectionnerait ensuite une personne à même cette liste.

Recommandation 5: Le régime de contrôle optimum au sein d'une société de la Couronne devrait comprendre des punitions, des récompenses et des mécanismes d'évaluation.

Recommandation 6: Les objectifs des sociétés de la Couronne devraient être revisés périodiquement, en insistant particulièrement sur la nécessité de les poursuivre. S'il n'est plus possible de justifier à nouveau les objectifs, la société devrait être vendue au secteur privé ou dissoute.

The Organization and Control of Crown Corporations

Abstract

In determining the form and degree of appropriate delegation of decision making authority within public corporations, it is particularly important to evaluate the specific goals of the firms in question and the nature of the information which is likely to be available at reasonable cost to the relevant parties -- the public at large, parliament, the responsible minister and the corporate management.

In deciding the degree of delegation, moreover, one must not overlook the costs of overcoming the informational asymmetries. These costs will also aid in the definition of both the nature of performance monitoring and level of pre-decision monitoring undertaken within the firm.

Efficient performance monitoring requires two instruments: (a) low cost and low error monitoring devices; and (b) effective reward and punishment mechanisms. These are complements, in the sense that monitoring without appropriate rewards or punishments is not likely to lead management to follow the desired goals or devote sufficient effort. However, efficiently designed reward mechanisms may be a good substitute for monitoring to the extent that they succeed in eliminating conflicts between the organizational goals and the interests of management.

This study addresses the control problems within public corporations. In doing so, we explore alternative organizational forms to the public corporation together with their inherent control problems and methods employed to resolve these control issues. The applicability of these solutions to the public firm is also discussed. The study also examines the pre-decision and post-decision/performance based mechanisms employed to control the behaviour of the executives of public corporations. The problem of executive selection is examined as well within the context of developing an optimal incentive mechanism. Finally, we examine the internal control mechanisms directed at inducing the optimal effort from workers.

The analyses undertaken leads to a number of recommendations which are intended to improve upon the control of Crown corporations in Canada.

Recommendation 1: The objectives of Crown corporations should be clearly specified and where possible, algorithms should be developed

to provide an unbiased process of evaluation.

Recommendation 2: The role of the Auditor-General should be expanded.

Recommendation 3: The government guarantee of a Crown corporation's debt should be eliminated.

Recommendation 4: The appointment of top executives of Crown corporations should be a two-stage process. An advisory committee from the private sector should submit a list of qualified candidates to a Parliamentary committee which should then select a person from this list.

Recommendation 5: The optimal control scheme within a public corporation should be a combination of penalties, rewards and monitoring mechanisms.

Recommendation 6: The objectives of Crown corporations should be periodically reviewed with specific reference to the need for their continuation. If renewal is no longer justified, the corporation should be sold to private interests or dismantled.

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The Organization and Control of Crown Corporations

1.0 Introduction

The problems associated with the organization and control of private corporations have received considerable attention in the recent economic literature. Although the problem is not new (c.f. Berle and Means, 1932), increased emphasis and new perspectives have been applied due to recent theoretical developments in the theory of agency and optimal contracts. While these theoretical developments have been widely employed in private corporations, comparatively little has been applied to the problems of the organization and control of public corporations.

The fundamental source of the control problem in any organization, public or private, is the delegation of decision making authority to one party (agent) to transact business on behalf of the other party (principal). When this situation exists and the decision-maker has relevant information unknown to the principal (asymmetric information) together with diverse preferences (usually represented by diametrically opposed views about the optimal level of effort to be undertaken by the agent), the need for control mechanisms of one form or another arises.

In determining the form and degree of appropriate delegation of decision making authority within public corporations, it is particularly important to evaluate the specific goals of the firms in question and the nature of the information which is likely to be available at reasonable cost to the relevant parties--the public at large, parliament, the responsible minister and the corporate management.

While in general one may characterize the goals of any public corporation as: "maximization of social welfare", this definition is entirely inadequate, even when it is narrowly defined as is common in most economic analyses as the sum of consumer and producer surplus. This is because frequently the raison d'être of the public corporation is the existence of externalities and other nonconcavities. As well, political considerations relating to the redistribution of income or wealth, or to the supply of public goods, are dominant. A large number of possible explanations for the existence of public corporations have been explored and it is beyond the scope of this study to evaluate the rationale and validity of these explanations. However, it is clear that it is necessary to allow for possible variation in the goals of government corporations in order to determine the proper degree and form of delegation of authority which the government or parliament should exercise.

Integrally related to the problem of organizational goals and the delegation of decision making power is the question of information availability. Because information allows the decision maker to overcome uncertainty and, hence, make "better" decisions, ceteris paribus, the party with more information should be delegated decision making authority. To extend this point furtner, suppose we classify information into two categories: technical and political. In general, management of a particular corporation is likely to possess better information on the technical aspects of the firm, i.e. on materials and costs of delivering the good or service as well as demand considerations. The government, on the other hand, is more likely to possess better information on the political factors relating to the firm, i.e. on the redistributional or public goods considerations relating to the basic demand for the goods or services produced by the firm.

The degree of autonomy accorded management, moreover, can reasonably be expected to be a function of the stability of the goals. Thus, where a continuous reading of the public pulse is required, in order to satisfy demands which may change significantly and frequently, politicians are more likely to possess the information necessary and, hence, are more likely to retain a considerable degree of detailed control. Therefore, distributional and public goods issues which fall into this area tend to be delegated to government departments, rather than to public corporations.

As the degree of political knowledge required becomes less important, however, and the informational aspects of a technical nature gain increased significance, a greater degree of delegation is both necessary and desirable. Thus, where organizational goals can be defined in a consistert way, and where these goals are relatively stable over time, a public corporation may be the more appropriate institutional structure. Since the focus of this study is with information of a technical variety, our concentration is, therefore, on the institutional arrangements (primarily public corporations) appropriate for dealing with these considerations.

This argument highlights the need for a clear definition of organizational goals in order to insure technical efficiency by public corporations. Only through such a specification of goals can the informational requirements of technical management within the firm be assured of dominating the informational requirements associated with the political demands from outside the firm. Hence, in order to achieve technical efficiency, a high degree of delegation of authority to management is required together with a low level of political involvement within the decision making process of a public corporation.

The delegation of authority, however, is not without its costs, those being the negative externalities that may be imposed by one party on another because of the informational asymmetries present in the economic relationship. When the private information concerns the behaviour of individuals, the resulting externality is called moral hazard. On the other hand, when the information concerns the attributes or beliefs of individuals, or the quality of production technologies, the externality is referred to as adverse selection. For example, when ownership and control are separate, management knows its input of managerial effort whereas the owners do not because they receive only noisy signals (caused by the interaction of effort with other input factors and random disturbances) such as accounting income figures that do not reveal the exact input level. In this case, a negative externality is imposed on the owner because the information asymmetry allows managers to pursue their individual goals at the expense of the owners' goals.

In deciding the degree of delegation one must not overlook the costs of overcoming the informational asymmetries. These costs will also aid in the definition of both the nature of performance monitoring and level of pre-decision monitoring undertaken within the firm.

Efficient performance monitoring requires two instruments: (a) low cost and low error monitoring devices; and (b) effective reward and punishment mechanisms. These are complements, in the sense that monitoring without appropriate rewards or punishments is not likely to lead management to follow the desired goals or devote sufficient effort. However, efficiently designed reward mechanisms may be a good substitute for monitoring to the extent that they succeed in eliminating conflicts between the organizational goals and the interests of management. In the private sector this is exemplified by tying

executive remuneration to stock market performance and in so doing, executive and shareholder interests are made mutually consistent which in turn reduces the degree of required monitoring.

Within any organization, moreover, there is a hierarchy that results in two distinct control problems which are associated with the upper and lower echelons of employees within the firm. At the lower end of the spectrum, workers may shirk and are controlled by internal mechanisms--rewards, penalties, and supervision. At the higher end, control is directed toward management to ensure that the interests of the owners are being reflected in their actions. In private corporations, these control mechanisms are most often external and take the form of: (a) the stock market which serves as an independent monitor and evaluator of performance, (b) markets for executives which supply rewards to successful executives and even allow risk reduction on their part, (c) institutional arrangements that provide for full disclosure of the firm's records, and (d) the threat of takeover by another firm. Clearly, when one focuses on public corporations, many of the external mechanisms are unavailable so that internal schemes which are typically used to motivate workers must be designed and used to provide managerial incentives as well.

Within public corporations, the problem of worker control using internal mechanisms involves the optimal organization of hierarchies and incentive structures so as to increase efficiency and ensure the identity of interests of employees and the owners of the corporation (i.e. the taxpayers). In many cases, the problems do not differ significantly from those of private corporations, so that successful organizational forms and internal incentive structures can be safely borrowed from the private sector. However, in some cases, the problems of providing correct incentives to workers within public corporations are different than in private firms. For example, the risk characteristics of the

two enterprise types may differ significantly, as well as the nature of the goals pursued--and hence the criteria for success. It is, therefore, important to evaluate these differences and their implications for optimal control.

Because risk elements, due to uncertainty and ignorance, constitute such a major problem in the design of optimal control mechanisms, it is particularly instructive to evaluate the way in which risk enters the decision-making process within public corporations. In particular, government ownership can be viewed as the provision of risk-underwriting by the government. This insurance would not be provided by institutions in the private sector due to moral hazard and transaction costs. That is, the absorption of risk by government in the case of public corporations relieves those involved of both the costs of failure and any reward for success. The independence of rewards from the outcome may alter the employee's effort and, hence, the outcome itself. The implication is greater agency costs when rewards are independent of the outcome of their decisions. Moreover, transactions costs are associated with the determination of the expected return to a project, monitoring the activities of those involved with a project, and enforcing the terms of the contract with respect to the claims of the government to the residual returns.

These problems are compounded by the complexity of the goals of government enterprise. Unlike private enterprise which has a relatively simple goal--long run profit maximization--subject to risk considerations, publically owned firms are usually established precisely because long run profit maximization is considered an incomplete or even undesirable element in the wider picture of "social welfare". Hence, the evaluation of performance may become complex and this imposes additional restrictions on the form of incentive contracts in addition to the unavailability of share options and other similar instruments.

Finally, the problem of risk is also magnified in public corporations. First, unlike private corporations, shareholders cannot self-select to invest in corporations according to their risk characteristics. Moreover, the government supplies some sorts of insurance to public corporations, even when they resort to market financing; thus the cost of capital is distorted. As in all insurance this leads to moral hazard problems which may involve an inappropriate degree of risk taking, which is compounded by the unavailability of appropriate incentive schemes for risk sharing. These problems complicate the optimal design of both the internal performance mechanisms used to control workers and managers within the public firm.

While ideally an incentive mechanism might be designed to induce the optimal effort by executives of public corporations, the available mechanisms suffer from problems of equity distribution so as to make them unattractive from a practical standpoint. Hence, what is needed is a second-best reward/punishment scheme complemented by monitoring.

Because monitoring is such a critical component of internal performance mechanisms, the inevitable question is: who should perform the monitoring within the public corporation? Of course, one of the functions of management in any organization is to supervise those below in the hierarchy. In the end, however, it always remains to ask: who monitors the monitor? If the government of the day is the designated monitor, the prospect of evaluating performance only by using short-term political goals surely exists. In contrast, an expanded role of the Auditor General to encompass both monitoring and performance evaluation of public corporations would appear to provide the required objectivity that would be in society's best long-run interests.

As mentioned earlier, in many cases the problems in a public corporation do not differ significantly from those of private corporations, so that successful organizational forms and internal incentive structures can be safely borrowed from the private sector. Hence it is important to examine the alternatives to a public corporation, specifically regulated and unregulated private firms, to identify internal incentive structures that may be effectively applied to the public firm. At the same time there are market institutions in the private sector (e.g. the stock market, the financial market system, etc.) that may not be directly applicable to the control of public firms, but which may provide greater insight into ways of using the available mechanisms more effectively. An examinztion of these is also an essential ingredient to a better understanding of the organization and control of public corporations.

When serious limitations exist, moreover, regarding the administration of rewards and punishments, pre-decision monitoring may also be desirable. Thus, for example, where the consequences of capital investment and other major policy decisions possibly extend beyond the tenure of the executives and, furthermore, the consequences of their actions far exceed the scope for punishment, it is reasonable to expect that public corporations be required to submit their corporate plans for approval or even compete with other public firms for their capital budget.

Whether we are talking about pre-decision monitoring or incentive mechanisms designed to produce behaviour compatible with the ownership of the firm, it is important to recognize that each of these schemes is designed to induce the optimal performance from the present staff. An important characteristic of an incentive mechanism is that, aside from inducing the optimal performance from the given quality of staff, the mechanism should also

provide for self-selection of the highest quality individuals into the firm. The design of an optimal incentive mechanism should incorporate both of these characteristics.

The study proceeds as follows. Section 2.0 critically examines alternative incentive mechanisms that have been suggested in the literature for application to both the public and private sectors. Section 3.0 explores alternative organizational forms to the public corporation together with their inherent control problems and methods employed to resolve these control issues. The applicability of these solutions to the public firm is also discussed. Section 4.0 examines the pre-decision and post-decision/performance based mechanisms employed to control the behaviour of the executives of public corporations. The problem of executive selection is also examined within the context of developing an optimal incentive mechanism. Section 5.0 explores the internal control mechanisms directed at inducing the optimal effort from workers. Finally, Section 6.0 is by way of a summary and presents the recommendations derived from the analyses in the study.

2.0 The Theory of Incentives

The theory of incentives is concerned with the problem that a planner faces when his own objectives do not coincide with those of the agents. This lack of coincidence of goals distinguishes incentive theory from the theory of teams (Marschak and Radner, 1972) which postulates identical objectives. In turn, when one examines the problem in a social context, the planner, often the surrogate for society, has well-defined objectives which distinguishes incentive theory from social choice theory which examines the possibility of deriving social objectives from those of individual preferences.

As Laffont and Maskin (1982) point out in their overview of the theory of incentives, for an incentive problem to arise, noncoincidence of goals is not enough. The planner must care about either what agents know or how they behave. That is, his objective function must depend on agents' information or on their behaviour.

The planner pursues his objective(s) by the choice of an incentive scheme which is a rule specifying, in advance, the planner's behaviour on the basis of his perceptions of agents' information and actions. This choice, however, is nontrivial if either (1) some of the agents' payoff-relevant information is not known to the planner (adverse selection problem) or (2) the planner cannot observe the agents' actions perfectly (moral hazard problem).

In the remainder of this section we shall present a brief review of the general problem of incentive compatibility followed by a discussion of incentive compatible mechanisms in public organizations.

2.1 The General Incentive Problem

In the spirit of Laffont and Maskin (1982) who present a general framework to be used in their overview of the theory of incentives we consider a model consisting of a planner and n agents (indexed $i=1,\ldots,n$). Each

agent i has private information represented by $\theta^i \in \Theta^i$. On the basis of this information, he sends a message $m^i \in M^i$ to the planner. The planner, in turn, replies to these messages with response $r \in R$. The agent then chooses an action $a^i \in A^i$. While the planner cannot, in general, observe a^i directly, he can observe the outcome $y^i \in Y^i$ of a^i, θ^i and his own response r, where y^i is, in general, random. Finally, the planner selects decision $d \in D$. An incentive scheme is a choice by the planner of the message space (M^j), response function (ρ), and decision function (δ).

To see how the elements of the model fit together, Laffont and Maskin present the following scenario. Suppose that agents are production units and that the planner wishes to allocate capital efficiently across these units. Each agent i produces output from capital and labor according to the production process θ^i, known, ex ante, only to him. The planner asks each agent to provide data about his own process. Thus, m^i consists of one of a number of possible messages that i could send about his production technology. Based on this data, the planner allocates capital across units. Thus, r is an allocation, and ρ an allocation rule. Given his capital, agent i then chooses a quantity of labor a^i. Capital, labor, the production process and, perhaps, nature combine to produce the random output y_i. Finally, production units are rewarded by the planner according to the rule δ based upon their output (performance) and the information they provided.

For a specified solution concept, the planner's problem is to choose an incentive scheme whose equilibrium maximizes his expected payoff. The solution concepts can, moreover, be divided into three categories: those that can be defined without reference to the information that agents possess about one another (e.g. equilibrium in dominant and maximin strategies); those that require the vector θ of informational parameters to be drawn from a joint

probability distribution (e.g. Bayesian equilibrium); and those that, in effect, assume complete information (e.g. Nash equilibrium).

By far the strongest, but in many respects the least controversial, solution concept is that of equilibrium in dominant strategies. A dominant strategy is one in which an agent, given his information, is willing to use regardless of what he believes others know and the way he believes others behave. The principal limitation of the dominant strategy solution concept for the planner (apart from its neglect of possible collusion by agents) is the difficulty of designing incentive schemes whose dominant strategy equilibria generate a satisfactory payoff for the designer.

Maximin strategies, like dominant strategies, implicitly ascribe to an agent neither a theory of what others know nor a theory of how they behave. Maximin equilibrium, however, imposes a very strong method for resolving strategic uncertainty, namely extreme pessimism.

In contrast, the Bayesian solution concept developed by Harsanyi (1967) is defined explicitly in terms of an agent's beliefs about others. In the Bayesian setting, to predict that agent j will use a particular strategy rule, one must attribute to him not only probabilistic beliefs about θ but also beliefs about others' beliefs about θ, i.e. beliefs about beliefs about beliefs, etc. This is indeed a nontrivial problem for the planner.

The final solution concept, which has the characteristic that it assumes complete information, is the Nash equilibrium. If we let θ^i incorporate all of agent i's information,

$$\theta^i = (\theta^i_i, \theta^i_{-i})$$

where θ^i_i can be interpreted as agent i's information about his own preferences, etc., and θ^i_{-i} represents i's information about others. The

assumption of complete information embedded in the Nash equilibrium can then be stated as

$$\theta_k^i = \theta_k^j \quad \text{for all} \quad i,j \text{ and } k$$

That is, i's information about k's preferences, etc. is the same as j's information about k. Formulated in this way, a Nash equilibrium is a special case of a Bayesian equilibrium.

One of the fundamental weaknesses of the Nash concept is that if agents have complete information about each other's preferences, then the planner should have this knowledge too. If so, he can simply choose the optimal allocation, avoiding the design of an incentive scheme altogether.

Nevertheless, there are at least two distinct justifications for the Nash equilibrium approach. First, it makes sense in many situations in which the planner is fictitious and the method of making collective decisions must be determined well in advance of the decision making itself. For example, in democratic societies, the allocation of resources to public goods is not imposed by an all-knowing planner, but is decided instead by legislative methods fixed long before people's preferences for any particular public good are known. Nonetheless, by the time that the legislators actually decide on a particular allocation, they may well have a good idea about what each others' preferences are or at least what the distribution of preferences is. Thus, Nash equilibrium may not be too bad a way to model behaviour in this situation.

The other justification for Nash equilibrium is quite different and relies on viewing an equilibrium as a stationary point of some kind of adjustment process. The idea is that at each stage of the process, an agent either responds explicitly to the others' current strategies by modifying his own

strategy, or if ignorant of what others are doing, experiments with his strategy and modifies it according to his experimental success or failure. In either case, strategy revision ceases when the current strategies form a Nash equilibrium, because only then will agents find further deviation undesirable. Thus, Nash equilibrium is the appropriate concept to predict the outcome, even though agents may not have complete information.

Given these four solution concepts to the incentives problem we now examine the specific application to public organizations. The interested reader, however, is referred to Laffont and Maskin (1982), Laffont (1979) and the Review of Economic Studies (1979) Symposium for a broader review of the literature than is presented here.

2.2 Incentive Compatible Mechanisms in Public Organizations

There appear to be three distinct areas where incentive mechanisms have been studied within the context of a public organization. The first group of papers deals with various versions of Soviet-styled incentive mechanisms, or sometimes referred to as elicitation schemes since the planner elicits targets from the firms under its control. The second series of papers is concerned with the optimal allocation of a common input among members of a group when the planner cannot observe each member's actual productivity from using the input, but must rely on reported figures. The optimal incentive scheme seeks to achieve the efficient allocation of the input under these circumstances. The original work in this area is attributed to Groves (1970) and most of the schemes that followed Groves' original work represent only minor modifications. Finally, the third group of papers explicitly considers the multi-period aspects of an optimal incentive scheme in the public sector and is identified with the recent work of Vogelsang (1983).

Because of their direct relevance to this study, we shall review and evaluate the papers in this section in greater detail than those which were presented earlier.

2.2.1 Elicitation Mechanisms

One of the earliest incentive mechanisms for a planned economy was presented by Gindin (1970). In his work Gindin recognized the effort-inducing effect of a bonus and the fear of a potentially higher new planned target when the current plan is fulfilled or overfulfilled. His model explains the managers' and planners' conflicting interests which are inherent in a planned economy and in doing so, considers the adjustment in the new target based upon the current target and actual production during the period.

At about the same time, Leeman (1970) discussed some bonus formulae in a Soviet-type economy. He noted that if a reward were given only for the fulfillment of physical output targets, managers would tend to ignore the volume and if the reward were based on volume, management would be indifferent to plans. Leeman also noted, however, that the bonus for overfulfillment induces the managers to understate their capacities. Hence, there is a conflict in the output plan and profit related bonuses associated with that plan.

Ellman (1973) analyzed a bonus system based upon profit which reduces the managers' incentive to understate capacity. Specifically, the bonus, B, is viewed as a function of forecasted and actual profits (π^F, π^A). In particular

$$(2\text{-}1) \quad B = \begin{cases} \varepsilon_1 \beta \pi^F + (1-\varepsilon_1)\beta \pi^A & \text{if } \pi^A \geq \pi^F \\ -\varepsilon_2 \beta \pi^F + (1+\varepsilon_2)\beta \pi^A & \text{if } \pi^A < \pi^F \end{cases}$$

where ε_1, ε_2, and β are bonus coefficients set by the planner and $\varepsilon_i \leq 1$. It is clear from (2-1) that the size of the bonus is positively related to actual profit irrespective of whether or not the firm meets or surpasses its forecasted profit. Furthermore, the scheme also provides the incentive for a higher forecast if actual profit exceeds the forecasted level yet at the same time, provides for a reduction in the forecasted profit if actual profit is below the forecast. Hence, truth-telling is encouraged by the Ellman scheme. Unfortunately, however, the long-term effects are overlooked in this type of myopic approach to the problem. That is, in the long-run, if actual profit exceeds the forecasted level, the planner may adjust the bonus coefficients. This is a real concern when firms operate in a planned economy and the actions taken today often do account for this possibility in the future.

Taking a somewhat different approach, Domar (1974) attempted to model the 1965 Soviet economic reforms which placed greater emphasis on profits and the replacement of the output target by sales. Specifically, the manager's bonus is viewed as a convex combination of net profit and total revenues, i.e.

$$(2\text{-}2) \quad B = u(px - c(x)) + vpx$$

where u and v are parameters, p and x are price per unit and total output respectively, and $c(x)$ is the total cost of producing x units. Taking the derivative of B with respect to output and setting the result equal to zero in order to find the production level which will maximize the manager's bonus, we have

$$(2\text{-}3) \quad p = \frac{c'(x)}{\left(\frac{u+v}{u}\right)\left(1+\frac{1}{E}\right)}$$

where $c'(x)$ is marginal production cost and E is the price elasticity of demand. Since the planner wants price equal to marginal cost, it desires the denominator of the right-hand side of (2-3) to equal 1, or upon simplication,

$$(2\text{-}4) \quad \frac{u}{v} = -(1+E)$$

Therefore, the parameters of the bonus function should be adjusted as the elasticity changes to ensure that price equals marginal cost is maintained. The problem with this formulation is that it is based upon the optimistic assumption that the elasticity of demand can be estimated and that both the planner and the manager arrive at the same estimate. Hence, this scheme is not informationally efficient.

A variation on the Domar scheme was suggested by Tam (1979, 1981) who considered a bonus composed of a weighted sum of profits and output. Tam argued that her scheme was superior to Domar's in two respects. First, Domar's scheme works only if demand is elastic at the optimal output level while Tam's structure works irrespective of the demand elasticity. Second, even when demand is elastic at the optimum level, there are circumstances for which output will converge faster under Tam's scheme than with Domar's. Tam concludes that the only information required of her model is the output levels of the various products provided by managers and the prices at which they are sold. The planner should be able to obtain this information quite easily and at relatively small cost. The major drawback of the Tam scheme, however, is that it requires myopic income maximization on the part of managers. If management instead behaves strategically and maximizes the discounted stream of future income, the optimal outcome of the adjustment process is no longer warranted.

Fan (1975) has taken an approach to the problem that is more practical in the sense that it is less subject to restrictive informational input requirements than is Domar's approach. Fan's indicator has, moreover, been used elsewhere by Ijiri, Kinard and Putney (1968) and Loeb (1974) in the context of management performance evaluation in a firm. Fan shows that managers operating under his reward system will have no incentive to understate or overstate their production capacity and will strive to attain their target profits set by the planning authority. Generally, the bonus scheme that achieves this is:

$$(2\text{-}5) \quad B = \alpha(x^A - \epsilon|x^F - x^A|)$$

where x^A and x^F represent actual and planned target production of the firm respectively. Now, let x^* be the maximum capacity of the firm. If $x^F = x^*$, denoting that the firm reports truthfully, and $x^A = x^F$, denoting the firm actually produces the target level, then $B = \alpha x^*$. If, on the other hand, the firm should choose to underreport so that $x^F = x^*-\delta$ and $x^A = x^F$, then $B = \alpha(x^*-\delta) < \alpha x^*$. Likewise, if the firm underreports and $x^A = x^*$ (produces more than the target), $B = \alpha(x^*-\epsilon\delta) < \alpha x^*$ so that this too is not an optimal strategy. Finally, if the firm underreports and $x^A = x^F - \gamma$ (produces less than the target), it follows that $B = (x^*-\delta-\gamma-\epsilon\gamma)<\alpha x^*$.

It is easy to show as well that overreporting and deviating from the target level of production results in a smaller bonus than would be realized if the manager reported truthfully and produced the target level of production. Hence, the incentive with this mechanism is for truthful reporting and production of the target level. Fan also examines the stochastic case and again concludes that using his scheme will provide no incentive for either underreporting or

overreporting. The shortcoming, however, with this mechanism is that it does not say how the capacity of the firm is chosen nor does it consider the multi-period consequences of the planner changing the bonus coefficients over time. Moreover, it has been shown by Loeb and Magat (1978a) that Fan's success indicator is not optimal since it pays for one firm not to tell the truth.

Perhaps the most notable of the Soviet-styled mechanisms is the structure presented by Weitzman (1976) which is based on the 1971 Soviet economic reform. The model can be expressed as a three stage interactive process:

Stage 1: Planner sets $\bar{\pi}$, the tentative target level of performance (e.g. profit, output, labor productivity, etc.) and $\bar{B}$, the tentative bonus.

Stage 2: Firm sets its planned target level of $\hat{\pi}$ with a planned bonus of $\hat{B} = \bar{B} + \beta(\hat{\pi}-\bar{\pi})$.

Stage 3: Actual bonus, B, depends upon actual value of the performance measurement, π, such that

$$B = \begin{cases} \hat{B} + \alpha(\pi-\hat{\pi}) & \text{for } \pi \geq \hat{\pi} \\ \hat{B} - \gamma(\hat{\pi}-\pi) & \text{for } \pi < \hat{\pi} \end{cases}$$

where $\gamma > \beta > \alpha$.

It is clear that truth-telling is a dominant strategy in the Weitzman model. Doing so (i.e. $\hat{\pi} = \pi$) results in an actual bonus of $B^* = \bar{B}+\beta(\pi-\bar{\pi})$. On the other hand, underreporting (i.e. $\hat{\pi} = \pi-\varepsilon$) results in a bonus of $\bar{B} + \beta(\pi-\bar{\pi})-(\beta-\alpha)\varepsilon<B^*$. Furthermore, overreporting (i.e. $\hat{\pi} = \pi+\varepsilon$) results in a bonus of $\bar{B}+\beta(\pi-\bar{\pi})-(\gamma-\beta)\varepsilon<B^*$.

Once π is amended to be uncertain with a probability density function of $f(\pi)$, Weitzman shows that

$$(2\text{-}6) \quad \Pr(\pi \geq \hat{\pi}) = \frac{\gamma-\beta}{\gamma-\alpha}$$

That is, the optimal self-selected target is such that the probability of ex post plan fulfillment is the ratio of the difference in the coefficients. Hence, within this framework truth-telling can be induced, or at least its likelihood of occurrence increased through manipulation of the bonus coefficients.

In an extension of the Weitzman model, Snowberger (1977) explicitly accounts for risk aversion. He also relaxes the assumptions of (1) constant marginal productivity of effort, (2) constant marginal disutility of effort and (3) constant marginal utility of the bonus. Snowberger examines the role of effort in a deterministic and stochastic framework and finally, he formalizes a two period model using Ginden's (1970) linear adjustment equation, i.e.

$$(2\text{-}7) \quad \bar{\pi}_1 = \bar{\pi}_0 + \delta(\pi_0 - \bar{\pi}_0)$$

where δ is a parameter between 0 and 1; $\bar{\pi}_1$ is the planner's target next period; $\bar{\pi}_0$ is the planner's target during the current period and; π_0 is actual performance during the current period. Snowberger found a tendency for subordinates to bias reports of expected performance downward in his dynamic model.

In a quite recent paper, Atkinson and Neave (1983) examined the dynamic multi-period version of the incentive problem attempting to overcome some of the intractabilities that Weitzman and Snowberger found. Three stages are again envisioned where

Preliminary Stage: Planning center sets $\bar{\pi}_t$, a tentative performance target for the given planning period t. This tentative target is adjusted each period according to a function of past targets and performance.

Planning Stage: Subordinate announces $\hat{\pi}_t$, his production target.

Implementation Stage: Subordinate chooses the activity level π_t which

taken with some uncontrollable random variable η_t determines actual performance, i.e. $\pi_t + \eta_t$.

Actual performance in this model becomes known at the end of t, after all three stages in a given period are complete. Capacity level of performance, moreover, represented as π_0, is assumed constant over all periods. Capacity can only be exceeded by a particular realization of a random disturbance term.

The manager's bonus is any period t is further represented as:

$$(2\text{-}8) \quad B_t = \bar{B} + \beta(\pi_t+\eta_t-\bar{\pi}_t) - \alpha(\hat{\pi}_t-\pi_t-\eta_t)^2$$

Let $f_t(\bar{\pi}_t)$ be the last-period return function where

$$(2\text{-}9) \quad f_t(\bar{\pi}_t) = \max_{<\pi_t>} E\{B_t\} \text{ for all } \pi_t \leq \pi_0$$

Solving this problem recursively, Atkinson and Neave establish unbiased reporting and performance at the capacity level in each period.

The authors also describe the extension where the bonus includes a disutility of effort expressed in monetary terms. If this term is linear, the results are unchanged. If, however, the disutility of effort function is increasing in terms of its argument, the longer is the time horizon, the smaller will be the choice of performance level. In either case, though, reporting will not be biased. Unbiased reporting, however, will follow if the disutility of effort function is linear, the manager is risk-averse, and utilities are additive on each period's return.

A major shortcoming of the elicitation schemes was brought to light by Conn (1979). Conn proved that no elicitation scheme is optimal in the presence of resource allocation. One reason for this is that managers may not honestly report their capacities and another reason is that when behaving truthfully, they simply do not convey appropriate information.

2.2.2 Common Input Allocation Mechanisms

A second group of incentive mechanisms deals with the allocation of a common input among firms by a central planning authority. The papers are basically all versions of the original model developed by Groves (1970). Groves and Loeb (1975) applied the model to the allocation of a public input by a government authority. Loeb and Magat (1978a) stressed how their formulation of the problem explicitly takes account of the effects of the forecasts on the planner's allocation to firms while the Weitzman-type models ignore these effects. The authors show that using the Fan (1975), Ellman (1973) or Weitzman (1976) models can result in enterprises individually gaining by transmitting inaccurate forecasts which are to the detriment of society. On the other hand, they argue that their success indicator motivates accurate forecasts and efficient behaviour.

In a closely related paper, Loeb and Magat (1978b) showed that a class of performance indicators studied in the accounting literature is a subclass of success evaluators which have been proposed and used by Soviet planners. They also show how the planning center in a firm uses divisional forecasts and by doing so, a large class of situations are identified in which the proposed management performance indicators and the Soviet success indicators (i.e. Weitzman-type indicators) actually encourage the transmission of biased forecasts. Finally, they suggest a new performance evaluator (Groves-type mechanism) which is again argued to motivate accurate forecasts and efficient behaviour for a large class of environments.

Groves and Loeb (1979) have yet applied the same incentive mechanism to the problems of coordinating and controlling interdependent divisions of a large firm. In this foundation, each division's profits depend upon certain

coordinating decisions taken by the center. The results, however, are the same, i.e. accurate divisional forecasts and efficient behaviour.

To illustrate the Groves-type mechanism, assume that capital ($\bar{K}$) is to be allocated among n divisions or firms by the corporate headquarters or central planner. The planner selects the allocation $\langle \hat{K}_1, \hat{K}_2, \ldots, \hat{K}_n \rangle$ such that

$$(2\text{-}10) \quad \langle \hat{K}_1, \hat{K}_2, \ldots, \hat{K}_n \rangle \quad \max \sum_{i=1}^{n} \pi_i^F(K_i)$$

$$\text{subject to} \quad \sum_{i=1}^{n} K_i \leq \bar{K} \quad \text{and} \quad K \geq 0$$

That is, the planner presents the firms with a number of different allocations of tne common input K. Each firm is assumed to maximize its profit given its allocation of K by choosing L_i, a vector of local enterprise decisions. The planner chooses the allocation $\hat{K}$ that results in the highest overall reported profit. The value of the i-th firm's success indicator depends upon its realized profit π_i^A. However, realized profit depends on the enterprise's capital allocation, a function of reported profit (π_i^F) so that the i-th enterprise's success indicator can be represented as

$$(2\text{-}11) \quad S_i(\pi_i^A, \pi_i^F) = \pi_i^A(K_i) + \sum_{j \neq i} \pi_j^F(\hat{K}_j) - A_i$$

where $A_i = A_i(\pi_1^F, \ldots, \pi_{i-1}^F, \pi_{i+1}^F, \ldots, \pi_n^F)$ is any real value calculated independently of i's forecast.

Note that π_i^F affects S_i only through the allocation of capital $\hat{K}$. When i reports its true profit (i.e. $\pi_i^A = \pi_i^F$), then the planner will choose $\hat{K}$ that maximizes i's success indicator. Thus, by reporting truthfully, the i-th enterprise ensures that the planner will act to maximize i's own success indicator.

For a meaningful interpretation of S_i, the following definition of A_i may be used:

$$(2\text{-}12)\quad A_i = \max_{\langle K_1,\ldots,K_{i-1},K_{i+1},\ldots,K_n\rangle} \left[\sum_{j\neq i} \pi_j F(K_j)\right]$$

$$\text{subject to} \quad \sum_{j\neq i} K_j \leq K \quad \text{and} \quad K_j \geq 0 \quad \text{for all} \quad j\neq i$$

With A_i defined in this manner, S_i measures the marginal contribution made by i to total profits, or the opportunity cost of abandoning the i-th enterprise.

There are at least three desirable properties of this class of indicators:

(1) The indicator is strictly increasing in a division's own realized profit so that the manager has an incentive to maximize profit.

(2) Each division manager is best off sending accurate forecasts no matter what anyone else does (dominance property).

(3) While the success indicator depends upon everyone's forecasts, it does <u>not</u> depend on their realized profits and, hence, on their efficiency in making local operating decisions.

Unfortunately, however, the Groves mechanism does have significant limitations. First, it only works when the profit (utility) functions of the agents using it have zero-income elasticity for the common input. This is the case because the mechanisms involve transfers of income and only with zero-income elasticity is the marginal willingness to pay for the common input by an enterprise independent of the transfer to be received. Second, while the mechanism does elicit truthful preferences, it does not necessarily determine Pareto optimal outcomes, since total profit need not equal the sum of the distributions to the enterprises. Finally, these schemes, while not manipulatable by individuals, may indeed be manipulated by coalitions of individuals.

Though the performance indicators of the form given by equation (2-11) may reflect enterprise profitability, the sum of the values of all the enterprises' indicators may exceed, eaual, or fall below total profits, i.e. $\sum_{j=1}^{n} \pi_j^{A}(\hat{K}_j)$. Walker (1976) has shown that it is almost impossible to find functions $(A_1, A_2, \ldots, A_n)$ of the other enterprises' forecasts, such that the values of the indicators, as represented by (2-11), is guaranteed to equal total profits.

Green and Laffont (1977) have also shown that all performance evaluators which result in truthful forecasts must belong to the class of indicators given by (2-11). This result, together with Walker's theorem, implies that any set of indicators which always sum to total firm profit must not possess this dominance property. Therefore, it is almost always impossible to find a set of performance indicators which fully allocates overall profits, while also motivating decisions to send truthful forecasts, regardless of the accuracy of forecasts of the other enterprises.

The impossibility of a mechanism existing which simultaneously yields truthful revelations as a dominant strategy equilibrium and is also balanced is the primary reason for the limitations of the mechanism cited earlier. To rectify these problems, therefore, it is clear that one of these properties has to be relaxed, either preservation of balancedness or truthful revelations as a dominant strategy. Groves and Ledyard (1977), in an effort to preserve the balancedness condition, restricted the message space allowable for agents to quadratic approximations of their true willingness to pay function and demonstrated that the resulting mechanism both insures balancedness and has truthful revelation of preferences as a Nash equilibrium. Consequently, if one is willing to weaken the equilibrium requirements for preference revelation from dominance to Nash, one can use the Groves-Ledyard mechanisn and achieve balanced outcomes at Nash equilibria.

Unfortunately, as Schotter and Schwodiauer (1980) point out, the Groves-Ledyard mechanism cannot be considered the last word for at least three reasons. First, the Nash equilibrium condition is a weaker condition than the dominance condition. Even worse, there may not exist a dynamic process that will converge to such a Nash equilibrium because at each step of such a procedure the agents may misinterpret their preferences in an attempt to affect the future path of the process. Vernon Smith (1979), however, has offered experimental evidence demonstrating that the Groves-Ledyard mechanism does dynamically converge to a Nash equilibrium. Second, Green (1976) has shown that the Groves-Ledyard mechanism may not yield individually rational outcomes so that some agents may wind up worse off from participating in the scheme than they would if they had simply consumed their initial endowment. Finally, even if all these other difficulties could be eliminated, the problem of coalitional manipulatability still exists since the equilibrium resulting from the Groves-Ledyard mechanism may not be a strong Nash equilibrium.

The optimal incentive structure problem has more recently been amended to account for managerial effort. While Loeb and Magat (1978a) and Conn (1979) have shown that if input allocation depends upon the information supplied by managers, the Groves mechanism will induce managers to send accurate information while the Weitzman mechanism will not. On the other hand, if the supplied information is not used for input allocation, the Groves mechanism provides no incentive for accurate information transmittal whereas the Weitzman mechanism encourages accurate reporting.

In an interesting paper, Miller and Murrell (1981) found that if managerial effort is considered or if the center's objective is defined net of bonuses, there may not exist any incentive scheme (Weitzman or Groves) leading

simultaneously to truthful reporting and maximization of the center's objective function. Conn (1982), however, argued that the results derived by Miller and Murrell are not thoroughly satisfying. Simply the fact that a particular system is not able to meet an absolute performance standard in a particular environment does not mean that the system is either a failure or totally without merit. Conn further argued that output or profit maximization, as defined by Miller and Murrell, cannot be achieved by any economic system, even an ideal perfectly competitive market system, when effort disutility exists. He showed, though, that use of an alternative performance criterion (i.e. where costs include the opportunity costs of managerial effort) will allow a modified Groves incentive mechanism to perform optimally in the presence of effort disutility.

In a related paper, Harris, Kriebel and Raviv (1982) argued that the Groves-type models lack the divergence of preferences property which, along with asymmetric information, are essential ingredients for the incentive problem. Consider a firm, for example, in which information is asymmetric but in which there is no divergence of preferences between top management and divisional managers. The resource allocation problem in this case is trivial. Headquarters simply asks divisions to reveal their information and incentive compatibility problems do not arise. The Groves-type models, however, introduce the divergent preferences by exogenously restricting the set of allocation schemes which are considered. For example, only schemes are considered which involve compensation rules for the divisions which are strictly increasing functions of divisional profits. Thus, a division prefers higher divisional profits even if this results in lower firm profits. If, however, evaluation measures independent of divisional profits are allowed, they would

be optimal since divisions would have no incentive not to report their information truthfully. Hence, once divergent preferences are explicitly introduced into their model, Harris, Kriebel and Raviv find that an evaluation measure can be constructed that encourages truthful revelation.

Finally, a direct extension to the Harris, Kriebel and Raviv paper has been provided by Cohen and Loeb (1984) who show how a Groves scheme handles the problem of moral hazard. Like Harris, Kriebel and Raviv, they incorporate asymmetric information together with effort disutility, but assume a more general class of technologies than the special case of linear technologies studied by Harris, Kriebel and Raviv. Truthful revelation again prevails (dominant strategy equilibrium). The authors also show that when an effort variable is included in the analysis, profit sharing may induce a divisional manager to transmit misinformation so as to alter the division's allocation and reduce the effort level subsequently selected by the manager.

Before leaving our discussion of Groves-type mechanisms, we should point out the relationship of this structure to a game theoretic formulation of the allocation problem. Shubik (1964) has presented a scheme for allocating profits of a firm to its divisions based on the Shapley value of a game. His measure of divisional profit (the performance indicator) is similar to the indicator in (2-11) with A_i defined as in (2-12) since it also measures the contribution of each division to the firm's profits. Loosely speaking, it measures the average contribution of a division to all possible coalitions of other divisions and the headquarters. With such an allocation, managers wishing to maximize allocated divisional profits will take those decisions which also maximize total firm profits. A major problem with Shubik's scheme, however, is that it separates informational transmittal decisions from other decisions.

In order for the allocations to be calculated, the headquarters needs a great deal of information. By Shubik's own admission, his scheme is not foolproof against distortions of information and it may pay individuals to lie.

2.2.3 Multiperiod Incentive Mechanisms

A different approach to the problem has been pursued by Finsinger and Vogelsang (1981). They consider a state owned monopoly that produces outputs $X_t = (X_t^1, X_t^2, \ldots, X_t^n)$ in period t which sell at prices $p_t = (p_t^1, p_t^2, \ldots, p_t^n)$. The costs of providing X_t are $C_t = C_t(X_t)$ and the firm is assumed to be obligated to serve at the quoted prices. Demand and cost functions are stationary over time and are fully known to the manager but not to the government.

The proposed performance index is:

$$(2\text{-}13) \quad B_t = {}^{X}_{t-1}(p_{t-1} - p_t) + \pi_t - \pi_{t-1}$$

$$= p_t(X_t - X_{t-1}) + C_{t-1} - C_t$$

Under quite general cost and demand conditions the authors show that such a bonus will induce management to improve the firm's performance over time so that it converges to a social optimum. Furthermore, because management is forward looking, the process does not necessarily stop at a local, but non-global optimum.

Gravelle (1983) questions two assumptions made by Finsinger and Vogelsang that have significant consequences. Namely, in the F and V model, managers hold office in perpetuity which is not the case in the real world. F and V assume, unrealistically again, that either no managerial effort is required to reduce production costs or that such effort does not yield disutility to managers.

In contrast, Gravelle assumes managers have a fixed term of T periods and explicitly introduces effort together with its disutility to managers.

Within this framework, Gravelle shows that only during the last period in office will the manager wish to supply the socially optimal amount of effort. In all other periods, he will under-supply effort and production costs will be too high. The reason for this is that B_t in each period depends on the change in production costs in that period rather than on the absolute level of production cost. Hence, C_t enters negatively in t, but positively in t+1. Only in t=T will there by no offsetting future effects and will the socially optimal level of effort be extended. While intuition might suggest that managerial tenure be significantly reduced to eliminate this problem, there are other factors which offset this negative effect, e.g. learning by doing.

The primary cause of this problem is that managers only have usufruct rights and, in a public firm, cannot sell the right to enjoy the income stream generated by his decision. He, therefore, has little incentive to take account of the effects of his actions which occur following his tenure in office (i.e. only as a taxpayer or consumer). In contrast, within private firms owner-managers can sell the rights to future income streams, and, hence, there is an incentive to produce efficiently during their tenure.

In response to Gravell, Finsinger and Vogelsang (1983) argue that the last period of a manager's tenure is not the only efficient period as long as the firm's cost function does not exhibit intertemporal effects. The current effort only affects current period's costs and the optimal level of effort is extended in each period. This, however, is unlikely to be the case, so F and V suggest a pension could be paid which depended upon future performance of the

firm. Alternatively, they propose that employment contracts terminate randomly so as to minimize the future consequences.

Vogelsang (1983), moreover, recognizes the naivete of the F and V model in presupposing that managers simply maximize income or the discounted stream of future income. Alternatively, he introduces effort explicitly. Furthermore, because effort influences managerial utility whenever it is displayed, if effort is to be incurred each period, then it must be rewarded each period. Thus, the desired incentive mechanism must give cumulative incentives to management. The optimal bonus B_t^* in period t that achieves this is:

$$(2\text{-}14)\quad B_t^* = B_0^* + \sum_{j=1}^{t} p_j(X_j - X_{j-1}) + C_0 - C_t$$

Vogelsang shows that if managers maximize the discounted stream of future utilities, then use of B^* will lead to a sequence of welfare levels which converge to a welfare optimum. According to the author, the performance index has a number of highly desirable properties:

(1) Optimum effort is achieved in each period.

(2) The mechanism converges to a welfare optimum under rather general cost and demand conditions.

(3) The mechanism is extremely easy to interpret. Managers receive the full amount of any cost reductions they bring about plus a linear approximation of the corresponding increases in consumer's surplus.

The disturbing feature of the mechanism concerns its distributional properties. Not only will the firm have to be subsidized if increasing returns to scale prevail, but also the bonus payment becomes very substantial over time.

In recent papers, the multiperiod incentive mechanism has been applied to the regulated firm by Tam (1984) and Sappington and Sibley (1984). In the Tam model, the firm is taxed if it made a profit in the previous period and/or raises its price. On the other hand, the regulator grants a subsidy to the firm if the latter suffered a loss in the previous period and/or lowers its price. Tam shows that her scheme induces cost minimization on the part of the firm and converges to Ramsey prices. In contrast, the incremental surplus subsidy scheme proposed by Sappington and Sibley induces the profit-maximizing firm to price at marginal cost in every period; awards the firm strictly positive profits only in the first period; and induces the firm to operate at minimum cost in every period. In both of these models, the same drawback applies. Either no managerial effort is required to reduce production costs or such effort does not yield disutility to the managers. Certainly, neither of these conditions apply in the real world so that a practical multiperiod scheme must provide the motivation for managers to extend the effort required to reduce production costs in the present as well as all future periods.

3.0 Alternative Organizational Forms

Our basic assumption in evaluating the rationale for state intervention in the allocation of resources is that, unless proven otherwise, the normal operation of markets will effect an efficient deployment of resources. State intervention is justified where there is a reallocation of resources which would increase national welfare and that the market, if left to itself, would not effect this reallocation.

While many situations have been described in the literature as justifiable reasons for government intervention, it is necessary in each case to demonstrate that the resulting resource allocation with state intervention improves national welfare relative to that which would have occurred with the normal operation of markets. For example, it has been argued that public support of research and development is warranted in Canada. State intervention in the R&D area, however, can only be rationalized if, at the margin, the social return to R&D is greater than that yielded by alternative investments. Similar burdens of proof are borne by proponents of government intervention whose arguments are based on grounds of economic growth, employment, conservation, or risk-bearing.

Hence, the objectives of the government when considering involvement in private sector activities should be directed toward considerations of improved resource allocation. Among the many objectives cited to rationalize government intervention which are consistent with the goal of improved resource allocation are:

a. To improve efficiency and the ability to innovate and take major risks;

b. To regulate a natural monopoly;

c. To control the external benefits and costs of activities;

d. To ensure proper intertemporal use of natural resources;

e. To achieve social and economic equity; and

f. To serve as a yardstick competitor.

The objectives of the government, moreover, determine the criteria for performance evaluation. The more well defined and stable are the objectives, the more authority can be delegated by the government. Alternative organizational structures with varying degrees of delegated authority allow attainment of these objectives. In particular, public ownership is one of many instruments available to a government planning to intervene in the private sector. Figure 3-1, reprinted from Tupper and Doern (1981), presents a simple picture of the kinds and levels of instrument choices available to government when the need to intervene in the private sector arises. Under the public ownership column, representing the maximum level of coercion, the choices include a full Crown corporation (with its own statute), a joint public-private venture (created under the Companies Act), the acquisition of some or all shares, the acquisition of some or all assets, and the acquisition of the total supply of a firm's product through long-term contracts.

At the other extreme of minimum coercion, under the column headed by exhortation, are ministerial speeches, conferences, information dissemination, advisory and consultative bodies, studies (like the present one), royal commissions, and reorganizing agencies. Somewhere in between these extremes of coercive power lie government expenditures and regulation.

Tupper and Doern are quick to point out the difficulty in generalizing about the instruments in the figure. Doing so implies a theory of

Figure 3-1

The Instruments of Governing

Minimum ——— Degrees of Legitimate Coercion ——— Maximum

Exhortation	Expenditure	Regulation	Public Ownership
Ministerial Speeches	Grants	Taxes	Crown corporations with Own Statute
Conferences	Subsidies	Tariffs	Crown corporations under Companies Act
Information	Conditional Grants	Guidelines	Purchase of Shares of Private Firm
Advisory and Consultative Bodies	Block Grants	Rules	Purchase of Assets
Studies/Research	Transfer Payments	Fines	Joint ownership with a Private Firm
Royal Commissions		Penalties	Purchase of Private Firm's Output by Long-Term Contract
Reorganizing Agencies		Imprisonment	

Reprinted from Tupper and Doern (1981).

governing as well as an additional effort to generalize about more particular aspects of administrative and organizational behavior. Although the task is recognized by the authors as a useful one, two reasons exist for the general lack of optimism in fulfilling the job. First, instruments themselves are loaded with normative content. They are not purely the means for achieving a goal, but perceived by many as the ends. Second, the instruments must be related to broader public policy ideas and purposes as distinct from grand ideologies. That is, in certain policy fields, over an extended period of time, certain instruments are inextricably linked to central dominant ideas in that field by being the preferred or dominant instrument. Hence, generalizations are difficult and analysis of these instruments must rely on case studies of particular public enterprises which, by definition, only allows limited generalizations to be made.

With little opposition one can conclude, however, that the reasons for choosing one instrument over another depend upon the relative effectiveness of achieving the objectives set out by the government. Though no generalization can easily be made as to the conditions which warrant one instrument over another, Trebilcock and Prichard (1983) do provide a fairly comprehensive discussion of the relevant factors which we summarize below:

a. Monitoring and Information Costs

The vast literature on the theory of the firm has sought to explain why we observe firms internalizing the coordination of inputs rather than relying on the price system through independent contracting between entrepreneurs and the owners of the inputs. Coase (1937) suggested that the main reason for the development of firms is that there are costs to using the price system (e.g., the cost of finding out what the relevant prices are, the costs of negotiating a separate contract for each exchange transaction, etc.).

When a firm internalizes factor coordination, according to Coase, the character of the contract into which the factor owner enters with the firm is such that for a certain renumeration the factor owner agrees to obey the directions of the firm owner within certain limits. The owner of the firm directs the other factors of production within the same limits. When the costs associated with this process of direction are less than the costs associated with ascertaining relevant factor prices in the market and the transaction costs associated with separate contracts, it will pay the firm to internalize coordination of factors.

In a seminal paper, some time later, Alchian and Demsetz (1972) suggested that within the firm, the entrepreneur is a specialized monitor in directing the allocation of resources and has a strong incentive to perform his role efficiently by virtue of his being a residual claimant to the income of the firm after payment to factors. The authors also argue that the team production within a firm exceeds that attributable to the individual factors operating independently.

An alternative explanation for the emergence of firms was presented by McManus (1975) who emphasized the enforcement costs associated with using the price mechanism as a constraint on behavior, i.e., resources must be expanded in measuring the activity for which one is paying. In many situations, monetary constraints on behavior are not perfectly enforced because some changes in the activity of an individual will not be detected to the mutual satisfaction of buyer and seller. Where the buyer cannot perfectly enforce desired production from independent contractors, monetary incentives exist for the seller to cheat. If the cheating imputes sufficiently large costs on the buyer, it pays the buyer to specify the contractual constraints more clearly and enforce them more strictly, or alternatively choose a different and less costly form of economic organization for coordinating factor inputs.

Choosing a firm which either owns or employs many of the relevant factors may reduce the monitoring costs by engaging in continuous direction of the productive activities.

These explanations for the emergence of firms have a direct analogue in explaining the choice of public ownership vs. other forms of government influence. With few exceptions, each of the alternative governing instruments involves an incentive by the party being governed to undertake less than complete compliance. In the context of regulation, firm managers are motivated to act in their own interests through shirking and the comsumption of perquisites. At the same time the managers are also motivated to act in the interests of shareholders and overcapitalize.[1] Similarly, where the government is considering a subsidy to a private sector firm, it faces the costs of validating information from the firm, enforcing the conditions governing the use of the funds, etc.

The generalization that can be drawn is that the implementation of each governing instrument involves costs which are attributable to asymmetric information between the parties of the specific contract. The costs of acquiring the information required to induce the more informed party to act in the interests of the less informed party is a major contributing factor in determining the optimal governing instrument in each particular situation. An alternative, or complement strategy, to the acquisition of information is for the ill-informed party to provide an incentive for the informed party to act in the former's interest. This, however, is not without its own cost.

It should be recognized, moreover, that many of the following considerations are merely variations of the monitoring cost concept (as pointed out by Borcherding (1983)). Presumably then, in the absence of some unique and overriding factor(s), the optimal governing instrument is the one associated

with the least information costs.

b. Policy Coordination

Because policy coordination is not a costless exercise and each governing instrument is more or less effective in this respect, that instrument which is most efficiently adapted to the specific policy problems being addressed should be chosen.

c. Industry Structure

The structure and nature of the relevant industry will also affect the relative desirability of one governing instrument to another. In particular, the more competitive is the industry, the more information is generated for the government, thus reducing the costs of specifying and monitoring desired outputs. That is, competition among private firms serves as a form of monitoring and information production. At the extreme, perfectly competitive markets are characterized by free access to information on the part of market participants and socially optimal production levels so that government intervention is unwarranted. At the other extreme, a monopoly firm may enjoy an informational advantage which is responsible for the entry barrier associated with the firm's monopoly power and allows the firm the ability to restrict output from the socially optimal level. In this situation, a strong form of government coercion (e.g., public ownership or government regulation) may be justified.

d. Legal Limitations on Substitute Instruments

Trebilcock and Prichard (1983) further suggests that certain legal factors may limit the effectiveness of the various substitute regulatory instruments as techniques for aligning private sector activity with specified public objectives, thus favoring public ownership as the governing instrument.

There are, for example, certain sectors of economic activity where the constitution allocates regulatory authority to the federal government. Hence, a provincial government is not allowed to use direct regulation to intervene in this industry and may therefore choose public ownership to circumvent the constitutional powers granted the federal government. An illustration is the regulation of aeronautics which is a federal responsibility. A provincial government's only opportunity to participate in this sector may be through public ownership of an airline.

e. Functional Limitations on Substitute Instruments

Certain governing instruments are by their very nature functionally limited as mechanisms for aligning private sector activity with desired public objectives. Regulation, for example, relies on explicit legal orders which require definition and specification of a private firm's future conduct. In situations where setting such definitions or specifications is difficult if not impossible (e.g., changing technologies, new environmental conditions, etc.), public ownership is more effective. While Crown corporations also require direction, the greater flexibility in changing and communicating new directions with this instrument allows for a more effective mechanism in satisfying public objectives.

f. Low-Visibility Taxation

Politicians may be able to realize political advantages with a Crown corporation through the imposition of a tax (cross-subsidization) which has low visibility for the bearers of it. At the same time, this strategy requires the conferment of a monopoly on the profitable activities of the Crown corporation to prevent entry and the competitive erosion of the ability to cross-subsidize. Borcherding (1983), for example, argues that public ownership, compared to private sector regulation as an instrument of re-

distribution, is less open, more flexible, and more selective. These are indeed important political properties.

g. Symbolism; Ideology

In a situation where the government is providing substantial public support to a private firm, politicians may perceive a risk that if the firm were to make a profit at some future date, the government would be accused of using public funds for private benefit. The government may wish to own the firm in the form of a Crown corporation so as to allay such fears.

Public ownership may also be attractive as a way of symbolizing government's commitment to a particular cause or set of values. It may believe that only through public ownership is it possible to generate the public confidence and understanding of the government's commitment.

h. National Security; International Relations

Public ownership may also be desired for the opportunity to make decisions within the firm with a relative degree of secrecy not available with alternative governing instruments. National security is the most obvious situation to come to mind which is characterized by a high degree of secrecy.

In situations where Canada's international relations are affected by a firm's conduct, public ownership may offer the only reasonable vehicle for operating in international markets with a single voice so as to enhance the country's international posture and reputation.

Only when all factors are considered and the social return with each instrument tallied, can the socially optimal means of government intervention be chosen. Even then, however, political considerations may override economic considerations.

Regardless of the considerations for the intervention and its form, it is important to reexamine and reevaluate periodically both the rationale for government intervention and the form it takes. Conditions justifying such intervention are likely to change over time and, therefore, the success or failure of the intervention must be noted and the nature of the intervention adjusted accordingly. This is especially important where institutions, such as government enterprises, regulatory bodies, etc., are created to deal with a problem. These institutions tend to acquire a life and rationale of their own. The management and bureaucracy of such institutions generally attempt to prolong their life and expand it beyond the original mandate.

This is particularly true for institutions which do not involve a budgetary drain on the government, such as Crown corporations operating with some monopoly power, which in turn frees them from dependence on government funds. When this situation prevails, a large number of Crown corporations may continue to exist, even though the justification for public ownership may no longer be valid. Indeed, it is unclear whether the federal government is even fully aware of all public corporations in existence.

We therefore believe that a "sunset law" be enacted requiring renewal of corporate mandates every so often (perhaps 5 years) upon specified evidence about the need for its continuation and a clear identification of its functions. If renewal is not justified, the corporation should be sold to private interests or dismantled.[2]

In order to place this discussion in perspective, Figure 3-2 provides some specific examples of Crown corporations classified by objectives and the legal and institutional characteristics which discriminate between organizational forms.

Figure 3-2

Classification of Crown Corporations

Objectives	Monitoring and Information Costs	Policy co-ordination	Industry Structure	Legal Limits on Subs.	National Security
Natural Monopoly Regulation		Hydros			Telesat
Provision of Capital		FBDB IDC		ODC	
Yardstick Competition	Petro-Canada				
Control of Externalities	CN		AECL		
Nation Building		Hydros	AECL		Air Canada

Adapted from Trebilcock and Prichard (1983)

The purpose of this section is to examine alternative governing instruments to the public corporation, specifically government regulation, and in doing so, to identify the control problems within this structure and the methods employed to resolve these problems that might be appropriate for the public firm.

3.1 Government Regulation

Current regulatory practices represent a contract between society and the firm. In contrast to the Crown corporation where the government is the principal and the manager the agent, regulation adds an additional layer of bureaucracy, the shareholders, between the government and manager of the firm. This addition of a shareholder group in the regulatory environment has both costs and benefits. The costs include the rent allowed the shareholders that would, under public ownership, accrue to the taxpayers. The empirical evidence, while not conclusive,[3] supporting the theory that managers produce inefficiently in order to realize a higher return, supports the notion of shareholders being allowed to earn a rent.

The benefits of regulation relative to public ownership, on the other hand, include the reduction in information and monitoring costs attributable to the presence of shareholders. That is, the market value of shares is an objective measure of managerial performance and provides an effective incentive mechanism, stock options, for motivating managerial behavior consistent with the interests of shareholders. Moreover, the marketability of stock provides yet another force to discipline managers. Specifically, when management does not practice profit maximizing behavior, there is a deviation of the book value of corporate assets from their market value. Such deviations are invitations for corporate takeover bids as presently witnessed

by Unicorp Canada Corporation's attempt to gain control of Union Enterprises Ltd.

Aside from the takeover possibility, another disciplining force when a private firm is government regulated is one associated with the market for financial capital. In any private firm, where the possibility of management consuming perquisites reduces the ability of the firm to service its debt, the cost of raising funds in the capital market reflects this risk and is higher than it would otherwise be, thus discipling the firm. In contrast, within a Crown corporation, the debt of the firm is usually guaranteed by the government and, hence, does not reflect the underlying risk associated with management's consumption of perquisites.

A final disciplining force, though not unique to regulated firms, is the market for managerial labor. There is no reason to assume that managers are are not self-motivated to attempt to maximize the value of their human capital whether it be in a private firm or a Crown corporation. The distinction, however, is that in a private firm a manager's performance is more easily observed through increases in the stock price which, in turn, increases the value of his human capital. Even a competitive managerial labor market[4] will not find it easy to evaluate the performance of a Crown corporation manager so as to correctly value his human capital is the market and, hence, discipline him to act in the interests of the owner/taxpayers of the firm.

In the regulatory framework, moreover, it should be kept in mind that the regulator lacks perfect information since if costs and demand functions were known, the rate of return form of discipline is plainly inferior to a contract that specifies a large penalty if output deviates from the competitive level. To overcome the information asymmetry within the regulatory environment, various mechanisms have been suggested in the literature. The

following discussion of these mechanisms is based upon a review presented by Czamanski, et al. (1980), updated to include some of the more recent schemes that we have discovered.

In an attempt to classify the incentive mechanisms for ease of presentation, Czamanski et al. divide the schemes according to the source of information flows they generate and the reward structure by which agents are paid, recognizing that such an assignment is somewhat arbitrary and suggestive at best. Specifically, Table 3-1 describes the types of mechanisms discussed. Incentive mechanisms falling into categories A and C use information acquired directly from the agent alone while those mechanisms in categories B and D rely on information from the agent as well as other sources. Those mechanisms, furthermore, in categories A and B base the reward exclusively on the agent's productivity while the mechanisms in C and D base rewards on the productivity of the total system.

3.1.1 Type A Mechanisms

The first mechanism in this category was developed by the Federal Energy Regulatory Commission for use on the Alaska Natural Gas Transportation System construction project. The mechanism allows the company to realize a rate of return on common equity based upon a cost performance ratio (CPR) calculated as:

$$CPR = \frac{\text{Actual Construction Costs}}{\text{Estimated Construction Costs}}$$

where cost increases due to economic factors outside the control of management are excluded from CPR, but those increases due to project delays are included. The allowed rate of return on equity is then an inverse function of the CPR.

While this mechanism is attractive due to its simplification of the normal review process, without additional constraints imposed on the agent, there is an unambiguous incentive for the agent to inflate cost estimates.

Table 3-1

Classification of Incentive Mechanisms

Reward Based Upon	SOURCE OF INFORMATION: Agent Only	SOURCE OF INFORMATION: Agent and Others
Agent's Productivity	A	B
Total System Productivity	C	D

In a recent article by Fama (1980), the author questioned the need to implement incentive mechanisms. In his opinion, the managerial labor market is capable of inducing managers of both regulated and unregulated firms to choose acts that are in the best interests of security holders.

The main idea presented in Fama's work arises from his belief that management and risk bearing should be considered separate factors of production. The set of contracts, or the "firm", is disciplined, moreover, by competing firms, and each factor of production is disciplined by the opportunities provided by the markets for its services. Previous contributions of a manager to firm productivity are signals to the managerial labor market used to determine his opportunity wage. The previous associations a manager has had with firms, and his resulting successes or failures, give the market the information that is needed to assess accurately the manager's productivity, consequently allowing the market to determine the rental rate for the manager's human capital. Fama contends that self-interest gives the manager a stake in the success of the management team to which he currently belongs.

Fama recognizes that although the managerial labor market may be able to base an opportunity wage on a manager's past performance, there is still the uncertainty about the manager's choice concerning appropriation of non-pecuniary benefits over a period of time. This may result in a deviation from contract between the manager and other factors of production. Specifically, a manager consumes resources through shirking, incompetence, or consumption of perquisites to the point where marginal expected utility is equal to the additional dollar of wealth that may be used outside the firm. This causes the firm's value to be less than maximum.

When the manager is also the firm's only security holder, he cannot avoid full ex post setting up with himself; that is, he must pay for his deviation directly. Fama also states that some form of ex post settling up must also exist when the manager is not the sole security holder if incentive problems are to be avoided. Briefly, this is accomplished in Fama's world by assuming that the following two conditions are operative: (1) the managerial labor market is efficient in that it processes current and past information to revise future wages, and furthermore, the market understands any enforcement power inherent in the wage revision process, and (2) full control of managerial behavior through wage changes is accomplished by assuming that the weight of the wage revision process is sufficient to resolve managerial incentive problems. In short, rational managerial labor markets are cognizant of shortcomings in available mechanisms for enforcing ex post settling up, and assessments of deviations from contract will be incorporated into contracts on an ex ante basis, presumably through wage adjustments.

Fama's analysis provides a valuable framework for conceptualizing the manner in which information regarding a manager's marginal productivity might be absorbed by the managerial labor market and used in assessing the manager's future performance. In Fama's world, a full ex post settling up will result, assuming the manager perceives he will pay for his deviation from contract sometime in the future, via a process of wage adjustments.

3.1.2 Type B Mechanisms

Cost sharing contracts are an example of a mechanism which invokes the agent to share the risk with the principal in an attempt to encourage behavior consistent with the objectives of the principal. A typical cost sharing contract can be represented as follows:

$$\pi_A = \pi_E + \delta(C_A - C_E)$$

where π_A: actual profits;

π_E: estimated (negotiated) profits;

δ: cost-sharing rate where $0 \leq \delta \leq 1$;

C_A: actual costs;

C_E: estimated costs.

In this specification, the size of the cost-sharing rate (δ) determines the risk that each party bears during the enforcement of the contract. It is quite possible that asymmetric information on the part of the parties during negotiations could lead to a non-Pareto optimal solution.

As pointed out by Czamanski et al., this type of contract is sometimes written between utility companies and construction companies. Plant expansion efforts often lead to cost overruns that are shared by the utility and the construction company in predetermined proportions. The utility has a disincentive to control costs if it can easily include costs, resulting from poor management, in construction work in progress. Thus, the regulatory authority must take steps to monitor the firm's activities and to implement other types of incentive mechanisms designed to overcome these potential cost overruns.

A second mechanism in this category discussed by Czamanski et al. is insurance contracts with deductible clauses. Generally, this type of contract stipulates that the insured party is responsible for paying damages below some stipulated amount; the company will only pay for damages when they exceed some cut-off point.

The deductible clause in an insurance contract gives the insured party an incentive to avoid damages in much the same way that stock options, also a form of non-linear compensation, provide managers with an incentive to

behave in the owner's interests.

3.1.3 Type C Mechanisms

The two mechanisms discussed in this section focus on the existence of asymmetric information between the insiders (managers) and outsiders (shareholders) of the firm. The first mechanism, proposed by Ross (1977), is based on the conjecture that managers possess inside information and convey that information to outsiders about the firm's business risk and profitability by a process known as financial signaling. To induce valid financial signals, it is necessary to establish incentive mechanisms for the managers.

Ross has suggested one such incentive mechanism with the following structure:

1. At time 0, the manager gets paid a wage that is proportional to the current market value of the firm at that time; and
2. At time 1, he receives compensation that depends on the terminal value of the firm.

The total compensation to the manager ($\tilde{M}$) is:

$$\tilde{M} = \delta_0 V_0 + \tilde{Y}^m$$

where

$$\tilde{Y}^m = \begin{cases} \delta_1 \tilde{V}_1 & \text{if } \tilde{V}_1 \geq F \\ \delta_1 \tilde{V}_1 - L & \text{if } \tilde{V}_1 < F \end{cases}$$

and

V_0: current market value of the firm;

$\tilde{V}_1$: uncertain market value of the firm at the end of the period;

L: penalty assessed to manager if the firm goes bankrupt at the end of the period;

F: payments promised to the firm's debt holders at the end of the period; and

δ_0, δ_1: constants.

In this model, the key to the notion of financial leverage signaling is the term L, the penalty imposed if bankruptcy occurs. In a nonregulated firm, an increase in leverage, F, implies a higher probability that the manager will have to pay the penalty and receive less compensation in the next period. In a regulated firm,[5] however, higher leverage may impose less threat of bankruptcy through adjustments in the firm's allowed rate of return. Nevertheless, the regulatory authority and investors will observe the level of debt in the firm's capital structure and monitor the signals received by the firm's managers regarding their ability to service the debt payments. Since investors and the regulatory authority know that it is in the self-interest of the manager to avoid the penalty, leverage adjustments have informational content. A leverage increase has positive informational content, while a decrease in leverage may carry some negative content.

The incentive mechanism illustrated by Ross implies that managers will choose the capital structure to maximize their own wealth. Specifically, they will select the level of financial leverage where the marginal increase in the managers' current wage exactly equals the marginal increase in the present value of the penalty.

Although Ross deals with corporate debt policy, his incentive mechanism is an example of an effort to overcome the hazards of informational asymmetries. In Ross's framework, it is in the agents' interest to provide valid signals to outsiders in order to achieve firm value maximization.

Chen and Kim (1979) point out that Ross's model may break down, however, because there is an economic incentive for shareholders to make side payments to managers to induce false signaling. These side payments can be easily disguised as part of the normal managerial compensation. There is also an

incentive for both shareholders and bondholders in this framework to make side payments to managers to give false signals to the regulatory authority. These false signals may give rise to unwanted allowed rates of return or inflated rate bases.

In a related work, Leland and Pyle (1977) have developed a signaling model of capital structure and financial equilibrium in which managers seek financing of projects in which the true qualities are known only to them. The model assumes that managers will signal capital markets by their retention of a fraction of the equity in a project. The implication of the model is that agents must give valid signals to outsiders if the market value of a project is to be maximized. Even if an agent is prohibited from having a direct ownership interest in a project, there are other ways (e.g., stock options) to tie the manager's welfare to the success or failure of a project.

The manager, in this model, has a clear incentive to choose to hold a share of the project which will assure that equity financing will continue and which will, as well, maximize his own utility.

A limitation of the model, pointed out by Ross (1977), is that the market must know the risk preferences of the manager. It is in the general interest of managers, moreover, to misstate these preferences, resulting in the need for additional signaling mechanisms.

3.1.4 Type D Mechanisms

The mechanisms within this category include those discussed in Section 2.2 of this study. They encompass the elicitation schemes, the common input allocation mechanisms and the multiperiod incentive schemes. Since the more recent multiperiod schemes were only briefly discussed earlier and since they are most directly applicable to the regulated firm, we shall focus our attention here on these mechanisms.

In the Tam (1984) model of a regulated natural monopoly, the regulator is assumed to have no information on either the cost or demand functions ex ante other than past accounting information. The firm, moreover, is assumed to choose the pricing policy and the regulator in turn devises a subsidy scheme to induce Ramsey prices.

In each period, the firm either earns a profit or bears a loss. In addition, it pays a lump-sum tax equivalent to its profits in the last period or receives a lump-sum subsidy equal to its loss in the previous period. Moreover, if it increases its price from the previous period it pays a tax which is proportional to the increase. On the other hand, if it lowers its price from the previous period it recovers a subsidy, proportional to the reduction.

Under the above price tax scheme, the returns to a firm in period t (RET_t) can be represented as:

$$RET_t = \pi_t - T_t - \mu(p_t - p_{t-1})$$

where π_t is the profit (loss) in period t if positive (negative); T_t is the lump-sum tax (subsidy) if it is positive (negative) and equal to π_{t-i}; p_t is the per unit price charged in period t; and μ_t is the tax/subsidy rate on the price change from t-1 to t.

Tam demonstrates that her mechanism induces cost minimization behavior and converges to Ramsey prices. Furthermore, it does not induce strategic behavior on the part of managers.

There are, however, two drawbacks with Tam's incentive scheme. First, the convergence to Ramsey prices is quite slow for low discount rates. That is, of course, not unique to Tam's model, since any time there exists a low discount rate, the present value of an action is less sensitve to that discount rate and, hence, the incentive to postpone the activity is stronger.

To overcome this problem, it is necessary to increase the discount rate used by the manager. This will occur if the manager's degree of risk aversion increases or if the riskness of the outcome of his action increases to him. While changing the manager's risk attitude may not be easily within the principal's control, a share in the firm's residual income, and the associated risk thereof, will encourage the manager to use a higher discount rate and thus act in the principal's interest.

An even more glowing weakness is that no managerial effort is required to reduce production costs, or if effort is required in the model, it does not yield disutility to managers. The reality is, however, that cost reducing behavior requires effort which must be compensated. Furthermore, if the effort must continue each period for the cost reduction to be realized each period, the incentive scheme must recognize this and provide the appropriate compensation. This may take the form of either periodic remuneration equivalent to the cost reduction or a lump-sum payment equal to the capitalized value of the future cost savings.

In a closely related paper, Sappington and Sibley (1984) assume the regulator has no cost information, but does know the firm's demand curve and observes aggregate expenditures by the firm in earlier periods. The firm (managers), on the other hand, have full information on both demand and cost conditions. Under their incremental subsidy scheme, the subsidy in t is defined as:

$$S_t = \int_{p_t}^{p_{t-1}} Q(p)dp - Q_{t-1}(p_{t-1} - p_t) + E_{t-1} - Q_{t-1}p_t$$

where Q_t represents the quantity demanded in period t; p_t is the price charged in t; and E_{t-1} is the firm's total expenditures in t-1.

The first two terms that comprise the subsidy represent the welfare triangle that is gained as a result of the price change instituted by the firm. The last two terms reflect the amount by which expenditures in t-1 exceed the revenues that would be realized in period t if the quantity demanded remained at its level of the previous period.

The authors show that their scheme will:

(i) induce the profit maximizing firm to price at marginal cost in every period;

(ii) award the firm strictly positive profits only in the first period; and

(iii) induce the firm to operate at minimum cost in every period.

Unfortunately, this model too suffers serious drawbacks when its assumptions are compared to the realities of the regulatory environment. Firstly, Sappington and Sibley assume managers hold office in perpetuity so that they may be held responsible for all the future consequences of their present actions. While this assumption may seem quite restrictive, a similar effect can be achieved by assuming, alternatively, that managers are given stock options. As long as the market capitalizes the future expected earnings attributable to a decision made today, the current stock price reflects the future consequences of the manager's actions. Hence, it is no longer necessary to assume an infinite employment period.

The second problem that exists with the Sappington and Sibley specification is that it, like Tam's model, assumes either no managerial effort required to reduce production costs or that such effort does not yield disutility to managers. In either case, as discussed earlier, this is not a reasonable representation of the problem and effort, with its associated disutility to the manager, must be explicitly considered in order for the

model to have predictive power.

3.2 Summary

Since the regulated private firm is the most popular alternative to the public firms, both in the academic literature and in the "real" world, given that the conditions for government intervention warrant at least some involvement, we have focussed our attention on this organizational form. When reviewing studies of incentive mechanisms in the regulated firm, the distinguishing feature of these studies compared to those directed towards public firms is the availability of ownership shares. This yields an objective measurement of managerial performance and allows the firm to impute risk-bearing to the "manager" so as to aid in the resolution of the conflict of interest that is at least partially responsible for the principal-agent problem.

At first glance, the implication that might be drawn is that a joint public-private venture is the most appealing organizational form since all the incentives and monitoring benefits of private ownership would be combined with the socially optimal objectives of the public firm. This, however, is not the case since the optimal objective for the private firm is the maximization of the market value of the firm's common shares which is not necessarily consistent with the objectives of the publicly-owned firm. Hence, the unbiased evaluation mechanism usually present with common stock in private firms would no longer exist.

Hence, in the absence of privatization, incentive schemes in Crown corporations must contain a mechanism that performs the same function the stock market does in the private sector. That is, the mechanism must objectively capitalize the value of managerial effort for purposes of remuneration. Only in this way can the optimal level of effort be

encouraged in an environment characterized by a finite period of managerial tenure.

4.0 External Control Mechanisms in Public Corporations

Within the public corporation, as in any firm, there are essentially two problems of control: external and internal. External control involves, primarily, the mechanisms to insure that the public corporation as a whole, i.e., its top executives, operate in the interests of its ultimate shareholders--the taxpayers. In contrast, the internal control problem concerns the optimal organization of hierarchies and incentive structures within the firm so as to increase efficiency and insure the identity of interests of employees and the corporation. In this section we examine the problem of external control leaving the internal control problem for the next section.

Examination of the external control problem requires a clear definition of the interests which are relevant to the operation of the public corporation in question. While such definition may be different for different corporations and its detailed specification is beyond the scope of this study, it is necessary to set out some basic principles and classifications of such interest in order to determine the applicability of alternative control mechanisms for different types of public corporations.

An important distinction to be made is between the public interest in broad terms and the narrow short term interests of the government of the day. A democratic representative government ultimately is responsible to the voters, and thus may be presumed to operate in their best interests. However, the short run interests of the government of the day may, at least temporarily, diverge from the long run interests of the voters in particular directions, which may affect the policies of public corporations and divert them from pursuing the long run public interest. Thus, control

mechanisms must be such as to reduce the temptation for politicians and executives to use public corporations to pursue short run political or private gains.

4.1 The Conglomerate as an Analogous Organizational Structure

An interesting parallel to the structure of the public firm which exists in the private sector is a division of a conglomerate organization. Specifically, the conglomerate is similar to a government department. Within the conglomerate, the chief executive officer is the top ranking executive and is responsible to the board of directors who are in turn responsible to the shareholders. Similarly, within a government department, the minister is the chief executive and he is responsible to Parliament who in turn is responsible to the taxpayers. The conglomerate, moreover, is composed of divisions with each division operated by a president and a separate board of directors. The government department, on the other hand, contains Crown corporations with each firm also operated by a president and a separate board of directors.

From the standpoint of control, there are two features which clearly distinguish these forms of organization from one another. The first is the stock market which effectively disciplines the private sector firm. In the Crown corporation, there is no equivalent mechanism which objectively reflects the performance of executives and which, therefore, induces behavior in the best interests of the owners. In the private sector, moreover, the role of the auditor is generally quite restricted, with possible exception in multidivisional firms. Specifically, the auditor typically examines accounting data in order to express his opinion as to the reliability of that data. The audit is an effort to discover whether or not the financial statements do actually portray the financial position and

the results of operations of the company under examination. In the final analysis, the auditor of a private firm is responsible only for his own statement of opinion with respect to how well management's representations in the financial statements do or do not depict fairly the financial data they purport to reflect.

In the public sector, on the other hand, the role of the Auditor-General extends far beyond the verification of accounting data. Exactly how far the mandate of the Auditor-General actually does extend in allowing him to appraise and judge ex post the actions of a public enterprise is only now being examined before the courts as current Auditor-General Mr. Kenneth Dye presses for more information regarding the cost of the Petro-Canada takeover of Petrofina Canada Ltd. Of course, if Petro-Canada was a private firm whose stock was traded in the market, there would be no need for an appraisal of the takeover by a neutral third party since the firm's stock price would objectively reflect the purchase decision.

The market would have reflected both the reasonableness of the price paid and the desirability of the purchase given a reasonable price having been paid. The Auditor-General, on the other hand, is only responsible for the former. This is, of course, a shortcoming of the Auditor-General's employment relative to the stock market.

There are two kinds of audits, however, in multidivisional firms. First, there is performance auditing of divisions by the top management. Such auditing is combined with budgetary control and policy direction, as well as reward schemes. Second, there are stock market evaluations of corporate policy as a whole, combined with reward schemes for top management. Because the second type of information and reward system is deficient in governments, the incentive for effective performance auditing of public

corporations is also likely to be deficient. While the Auditor-General must not second guess political judgments, it is necessary that his role be expanded to investigate the way in which such political judgment is executed. Thus, given the goals by the designated minister, the Auditor-General should evaluate the efficiency of actions undertaken to further these goals. For example, the decision to create Petro-Canada is a political decision and outside the domain of the Auditor-General. However, whether the purchase of Petrofina was the most effective way to extend Petro-Canada's share in the industry should be evaluated by the Auditor-General.

While the Auditor-General may not perform all the functions accomplished by the stock market, an important factor associated with the individual collection of information by the Auditor-General concerns the efficiency of the information collection procedure relative to the efficiency of the stock market. That is, given equivalent incentives to collect information, the competitive market may overinvest due to duplication of effort whereas the monopolistic Auditor-General would not contribute to a similar waste of resources.

Granted, the opposition parties are motivated to collect information about the activities of the government of the day. Their resources are, however, severely limited and their intentions often politically inspired. Moreover, it is not at all clear whether the final jury, the taxpayers, interprets correctly the information disseminated from both sides of the House.

Hence, in the absence of the stock market as a neutral evaluator of a Crown corporation's actions, the scope of the Auditor-General's duties should be sufficiently broad so as to allow him a role which substitutes as closely as possible for the stock market.

4.2 Performance Evaluation in Public Firms

Within the private sector, aside from the stock market, there exists two other markets that effectively discipline managers - the managerial labor market and the bond market. While Fama (1980) has succinctly described the role of the managerial labor market in inducing managers in private firms to choose acts that are in the best interests of the owners, similar arguments cannot be drawn in the public sector. According to Fama, the previous associations a manager has had with firms, and his resulting successes or failures, give the market the information that is needed to accurately assess the manager's productivity and, consequently, allows the market to determine the rental rate for the manager's human capital. Fama contends, moreover, that self-interest gives the manager a stake in the success of the management team to which he currently belongs.

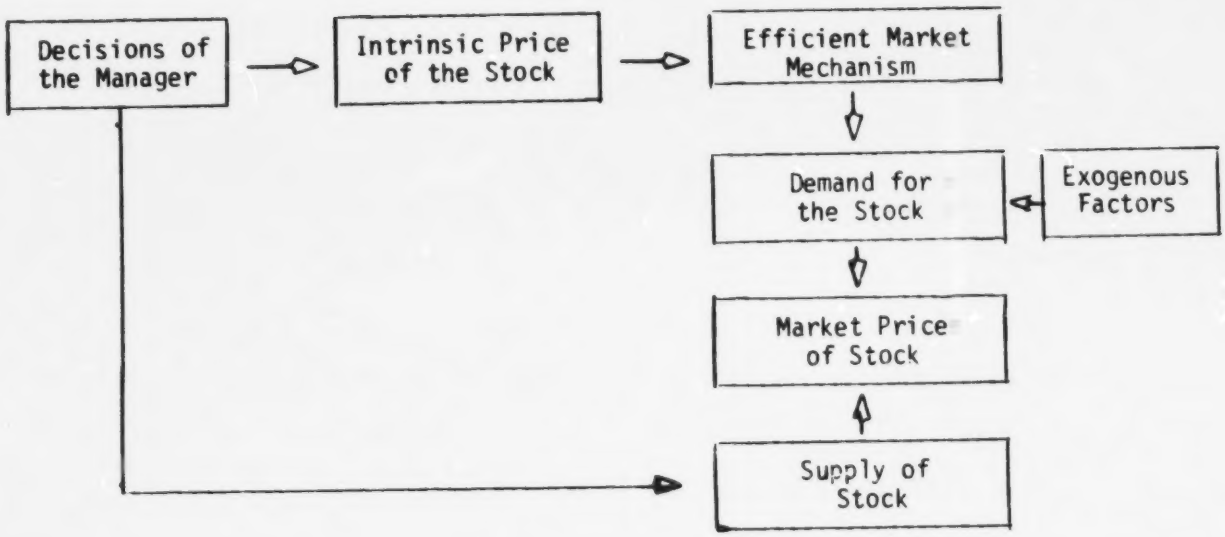
In the public sector, however, the labor market faces a much more difficult task in trying to evaluate past successes and failures in order to assess a manager's productivity. No longer is the objective of the firm so clear, and so measureable, as it is in the private sector. Therefore, there is no longer a straightforward and unbiased transformation to the rental rate for the human capital of a manager of a public firm. Hence, no longer is the external managerial labor market sufficient, and perhaps even effective at all, in disciplining managers. It is possible, however, to overcome these problems and resurrect the market as a disciplining agent by specifying clearly the objectives of public corporations so that the market can evalaute performance in a direct and impartial manner and assign to that performance an equally unbiased assessment of the manager's rental price of human capital.

The bond market is also an effective mechanism for disciplining managers of public firms - especially when the stock market is unavailable and the managerial labor market is ineffectual. Since a firm's decisions are typically reflected in the prices paid for the firm's bonds in the market, bond price movements represent an objective barometer of managerial performance. Unfortunately, however, this measure of performance which is available in the public sector is severely distorted as a result of the government guarantee visited upon the Crown corporation's debt. While there have been many arguments levied against the debt guarantee, based upon an inefficient allocation of resources (see, for example, Berkowitz and Halpern (1981)), the virtual elimination of the bond market as a disciplining mechanism must be added to the already lengthy list of reasons for removing this subsidy.

In the absence of effective market mechanisms, it is necessary to develop an alternative instrument for motivating managers. As has been stressed throughout this report, a clear specification of objectives is required at the outset in order to allow an unbiased evaluation of performance. The performance statement, moreover, must be translated into an algorithm which is equivalent to a stock market valuation. That is, in a private firm, the objective is clear: to maximize the wealth of the shareholders, as expressed by the market price of the shares. The outcome of the manager's decisions (or performance) can then be evaluated in terms of the stock price vis á vis the process described in Figure 4-1. Specifically, the manager makes a decision (e.g., investment, dividend, production, or marketing decision) which is reflected in the intrinsic price of the stock (or underlying true value of the stock as represented most often by the discounted future dividend stream). This information is then communicated to investors

Figure 4-1

The Stock Market Valuation



in the market and in turn impacts the demand for the firm's shares and, hence, the market price of the firm's stock.

While this mechanism provides a way to evaluate whether, for example, a particular investment undertaken by a manager was consistent with the objective of the firm, it does not ensure that the manager actually takes the action which is expected to have the greatest positive influence on the share price, especially if the interests of the manager and owners diverge. In order to overcome this divergence of interests, it is possible to extend ownership rights, for example, by giving stock options to the manager. However, as Jensen and Meckling (1976) have shown, this is only a partial solution as long as the manager is not himself the complete owner of the firm.

Though it admittedly does not solve the entire gambit of control problems within a private firm, the stock market valuation process does provide an unbiased procedure for evaluating performance. What is required in the public sector is an algorithmic approach which can serve a function similar to the one executed by the stock market in the private sector. That is, the capitalized value of an action must be determined in the same objective manner as in the stock market. Then, in order to motivate the manager, his remuneration should be based directly upon the capitalized value of his actions.

Unlike private firms, however, that are guided primarily by their share prices, public firms may have very different objectives and often multiple objectives as well. Hence, different algorithms are appropriate for different firms depending upon their specific objective(s). Therefore, in order to push this idea of an algorithmic approach to evaluation and motivation further, it is necessary to examine individual cases.

Let us first take the case of the provincial electric utilities. In this particular example, the raison d'etre for government involvement in the generation and distribution of electricity is the regulation of a natural monopoly.[7] Hence, the objective of these firms should be to produce and sell electricity in the most socially efficient manner over time. If we translate this objective into a formal prescription, it would be to maximize discounted social welfare (analogous to the intrinsic price of a share in the private sector), adjusted for distortions attributal to subsidies, taxes, and changes in income distribution. That is, in the case of a declining cost industry, it is well known that a marginal cost pricing strategy results in the firm operating at a deficit. In order to ensure the continued supply of the service, a government subsidy is often proposed. Raising these funds from the tax system, however, distorts relative prices throughout the economy and induces a resource misallocation. At the same time, there are costs associated with both the collection of taxes and distribution of a subsidy which also reduce overall welfare and must, therefore, be taken into consideration. Finally, it is not always the case that, in the opinion of the government of the day, all members of society count equally in the aggregation of individual welfare to arrive at the collective welfare of society. Some individuals, groups, or even regional disparities may be reflected in the social welfare function.

The exact adjustment, or the weight attached to the distortions, would be determined by the relevant department minister. Then, in order to evaluate a specific action undertaken by management, it is necessary to calculate the change in adjusted welfare associated with that action. The managerial incentive scheme would in turn be related to the change in welfare as is done

in both the Finsinger and Vogelsang (1981) and Vogelsang (1982) mechanisms.[8] One must keep in mind, however, that the multiperiod schemes require a system of rewards that induce the correct effort level in each period. Often this implies problems of equity distribution since the required incentive becomes very large over time. To overcome the distributional considerations, the incentive should be designed to illicit the correct amount of effort at the margin. That is, the reward should have a non-linear structure; no reward is received until the performance criterion reaches some pre-specified level. We shall come back to these issues later in this section when we discuss in more detail an incentive mechanism for public enterprises.

Another objective requiring a unique algorithm for evaluating the performance of managers is the provision of capital funds. At the national level, the Federal Business Development Bank, the Farm Credit Corporation, the Canadian Development Corporation and the Export Development Corporation create a substantial presence in the financial market.

The usual rationale for government intervention in the provision of capital is that imperfections exist in Canadian capital markets. As Mintz (1979) has stated, by imperfections we mean that (i) the government has a technological advantage such that the state can intermediate among consumers and firms at less cost in comparison to direct trading on stock markets or indirect trading through privately-owned financial intermediaries, or (ii) as a result of various institutional restrictions, created or tolerated by governments, privately-owned institutions may be prohibited from operating in specific areas of the capital market.

In addition to this efficiency explanation for government participation in the capital markets, it can also be argued that in some circumstances, in order to stimulate economic activity, the government should provide

capital to particular interests on terms different from those prevailing in the private market. That is, government may intervene to make capital available at a lower price than the private market would charge given the level of risk of the investment. As Trebilcock and Prichard (1983) point out, this may occur in situations in which there is a desire to promote economic growth through the expansion of the productive capacity of the particular industry. It may also be done in order to provide employment opportunities by making expansion plans more attractive to private firms than the market would dictate, i.e., to promote positive economic externalities that would not be taken into account by a private firm.

While the many rationales for government intervention in the financial markets are indeed diversified, the corresponding objectives of the particular state corporations operating in the Canadian capital markets are equally numerous and varied. Suppose, as an example, that the primary objective of one of these public firms is to provide medium and long-term funds for small businesses in order to fill the gap in the market caused by legal restrictions which have made it difficult, or impossble, for private lenders to provide these funds. The question then is, what criterion can we specify which reflects this objective and which, in turn, can be used to measure managerial performance?

Keeping in mind that the funds invested by the public corporation are replacing funds which are unavailable in the capital market due to legal restrictions, for example, the return required on these funds should be equivalent to that which would have been required by a private firm making the same investment. That is, the public firm must be compensated for the level of risk undertaken.

One approach for gaging performance that has been developed and primarily applied to the performance of investment fund managers is the Treynor index

defined for the i-th investment as:

$$T_i = \frac{R_{it} - R_{ft}}{\beta_i}$$

where R_{it} is the return earned on the i-th investment in period t; R_{ft} is the risk-free rate of interest in period t; and β_i is the systematic risk associated with the i-th investment, defined as the covariance between the return on the i-th investment and the return on the market portfolio (R_m)[9] divided by the variance of the return on the market portfolio.

The measure of Beta is usually obtained by regressing the monthly rates of return on a security, defined as the sum of the dividend plus capital gain divided by the security price at the beginning of the period, on the monthly rate of return on the market index. Usually, a three to five year time period is used in the regression. The regression coefficient which is the estimate of Beta is subject to a number of biases and sophisticated techniques that have been derived to correct for these problems.

Since the investment typically undertaken by a public firm is not in a publicly traded company, the risk measure, Beta, cannot be measured directly. However, indirect measures are possible. The finance-accounting literature is replete with articles which relate a market based risk measure - Beta - to accounting-based risk measures.[10]

As long as the Treynor index exceeds the excess return that would have been earned from an investment in the market portfolio (e.g., an index fund), i.e., $R_{mt}-R_{ft}$, that investment outperformed the market. Hence, the capitalized value of any investment undertaken by the firm is reflected in the value of the Treynor index associated with that investment. The incentive mechanism necessary to motivate managers to behave in the interests of the owner/taxpayers can then be based upon a weighted (by the amount of the investment) average of the T_i's associated with each of the investments

within the firm's portfolio.

As a final example, take the situation when the objective is clearly specified, but not quantifiable as in the case of the Canadian Broadcasting Corporation where the objective is nation-building. In the Canadian context, this objective involves promoting Canadian nationalism by developing a national identify and preserving Canadian control over certain services and sectors of the economy.

In a situation like this, where the objective is not quantifiable (e.g., CBC, Social Science and Humanities Research Council, etc.) it is not possible to develop specific algorithims. In these cases, judgmental elements must be used to motivate behavior and evaluate managerial performance. Panels of experts may be appointed for purposes of evaluation though the problem of self-interest bias may arise within the panel. It is important, however, that the institution be forced to play a zero-sum game. That is, the budget allocation is made externally and the internal experts allocate the pie. This is the procedure presently followed in most of these situations and it appears to be the proper method of dealing with the circumstance described by the firm's objective not being easily transformed to an explicit algorithm.

4.3 Planning and Evaluation Reform Proposals

It has been widely asserted that Crown corporations should be made more closely accountable to the executive and legislative arms of government as a means of control. Trebilcock and Prichard (1983) have summarized the various reforms suggested in recent years regarding the accountability of Crown corporations. The authors concentrate on the recommendations of the Lambert Commission on Financial Management and Accountability (1979), the Privy Council Office's Blue Paper on Crown Corporations (1977), and a Crown

Corporations Bill (Bill C-27) tabled in Parliament by the Conservative Government in 1979.

As to the modes of creation, the Lambert Commission suggested that the creation of a Crown corporation, or a subsidy thereof, should require express Parliamentary sanction in the relevant departmental or Crown Corporation Constituent Act and prior Governor in Council approval. Similar proposals are also contained in the PCO's Blue Paper and in Bill C-27. In evaluating this proposal, Trebilcock and Prichard point out that rules restricting the creation of Crown corporations or subsidiaries will have significant costs in cases where the Crown corporation is charged with making investments in highly competitive markets. That is, in certain takeover settings, the formation of subsidiaries of a Crown corporation to purchase shares anonymously through the market may be an integral part of a successful takeover.

Regarding the ex ante approval by government of the activities of Crown corporations, the Lambert Commission also recommended that capital budgets and operating budgets requiring appropriations be approved by the designated minister, by central agencies of government, by the Governor in Council and be tabled in Parliament with estimates. Again, both the PCO and Bill C-27 advanced similar suggestions. Trebilcock and Prichard argued that in many situations, it is likely to be extremely costly to relate budget information to competitors by tabling such information in Parliament.

The Lambert Commission also recommended that the chief executive officer of every Crown corporations be responsible for preparing a corporate strategic plan for the approval of the Board of Directors and for the information of the designated minister in evaluating proposed budgets on a year-to-year basis. Both the PCO and Bill C-27 proposed a similar requirement. Again,

Trebilcock and Prichard question the cost of this information in the hands of a competitor.

The Lambert Commission recommended as well the introduction of a generalized directive procedure, whereby a designated minister may issue policy directives to a Crown corporation, subject to Governor in Council approval and subject to tabling forthwith in Parliament. Trebilcock and Prichard point out that tabling the directive "forthwith in Parliament" may not be conducive to the objective of the directive since, again, the market gains a comparative informational advantage.

As to the ex post review of activities of Crown corporations, the Lambert Commission proposed that annual reports be furnished to the designated minister for tabling in Parliament. Also, the designated minister should be required to undertake a review of the mandate and operations of Crown corporations under his jurisdiction not less than once every ten years since either the objectives of the firm may have changed or the effectiveness of this particular instrument may have changed. Our recommendation of "sunset" laws in the last section confirms our strong support for this proposal.

According to the Lambert Commission, the auditor of a Crown corporation should also make periodic value for money examinations at least every five years and his report should be tabled in Parliament if he considers it warranted. This proposal is again consistent with our argument in the last section which called for an expanded role of the Auditor-General beyond simply the verification of financial data.

As Trebilcock and Prichard judiciously conclude, the general implications of the various proposals related to planning and evaluation reform in

public firms would seem to suggest a more case-specific application of these accountability rules is required.

4.4 Incentive Mechanisms for Public Corporations

Problems of agency arise whenever decisions are delegated to agents. As we have seen the raison d'etre of public corporations arises due to informational advantages of the technical cost and economic (marketing) aspects of operations, which agents/managers are likely to possess, relative to politicians. Thus, decisions about the means of obtaining political goals with the least economic cost are best delegated to such managers. However, this informational advantage leads to serious agency costs. Because managers are better informed than politicians, they will attempt to exploit this advantage by disguising rewards to themselves as necessary costs (perks), or more importantly, by not exerting sufficient effort and thought to corporate business.

The problem of disguised costs may be partly solved by post activity monitoring coupled with effective punishments, e.g., fines, demotions, firing or even minimal sanctions. This is usually done by auditing. However, the second problem of appropriate effort directed towards company goals is much more difficult to ascertain, due to the absence of standards by which to judge the amount and effectiveness of effort. Even with a significant expenditure on monitoring, the government is only able to observe the costs, output and quality levels of the corporation, but not to be in a position to evaluate them, because it does not know what is possible or appropriate.

The design of efficient incentive mechanisms attempts to reduce the social costs of this moral hazard problem, by inducing a coincidence of

interests of the organization with that of management. In the private sector this is genrally accomplished through performance bonuses or stock options for management. As well, managers frequently hold a significant ownership stake in their respective corporations. Thus, a significant, though incomplete, degree of coincidence of interest exists between managers and stockholders. However, stock options are less common in reward systems of lower echelon managers. In particular, divisional managers in firms which are organized in multidivisional form[11] are rarely compensated significantly by stock options, unless divisional shares are traded separately. This is because the correspondence between overall share performance and divisional performance is weak. As overall performance depends on all divisions, there is a serious free-rider problem, whereby each divisional manager free rides on the performance of others. Thus reward systems in multidivisional firms must be based on individual divisional performance indicators. The problems of design involved are similar to those of public corporations, though the criteria are somewhat simpler to measure.

To illustrate the problems associated with the moral hazard problem and its potential resolution, it is useful to formulate a very simple model of a natural monopoly subject to moral hazard due to unobservability of effort and unequal information about costs.

Assume that a natural monopoly faces a demand curve

(4-1) $$P = P(q) = CS'(q)$$

where CS is consumer surplus; q is output; and a prime indicates a derivative. Production costs, moreover, are assumed to be of the form:

(4-2) $$TC = F + b + s - ke + (c-e)\,q$$

shere F are fixed costs; b is cost of perks; s is executive remuneration; e is executive effort; ke is fixed cost reduction due to executive effort;

and c is variable cost. We also assume that managers know all cost parameters but the government knows only c and s. It may, however, observe past costs.

The manager"s utility is:

(4-3) $$U = s + b - g(e);\ g' > 0;\ g'' < 0$$

Note that -g(e) measures the manager's disutility per dollar of cost reduction. Thus it incorporates the disutility and the productivity of effort.

Because F and b are unknown and if s is a fixed salary, independent of output or cost, b is equivalent to profit from the point of view of the manager. To maximize utility, therefore, the agent chooses e*, such that g'(e) = k + q, i.e., the marginal utility of effort = cost savings due to it. Then output is chosen so as to maximize b, which is equivalent to profit maximization, i.e., q is chosen at:

(4-4) $$P + P'q = P(1 + \frac{1}{\eta}) = (c - e^*) \text{ or } MR = MC,$$

where η is the price elasticity of demand. However, because profit is disguised as cost, observed cost equals total revenue. This is denicted in Figure 4-2.

The results are thus identical to those of a monopolists with the socially optimal level of effort (given output) but price (P_m) too high. This is because the manager can appropriate the full benefit from a cost saving due to effort.

Note that auditing to reduce manager's ability to appropriate b will result in a corresponding decrease in e[12]. Thus, observed cost and output remain unchanged, as long as the minimum level of e is exceeded. However, such auditing is undesirable because aside from the waste of auditing costs, real production costs increase, so that both the manager and

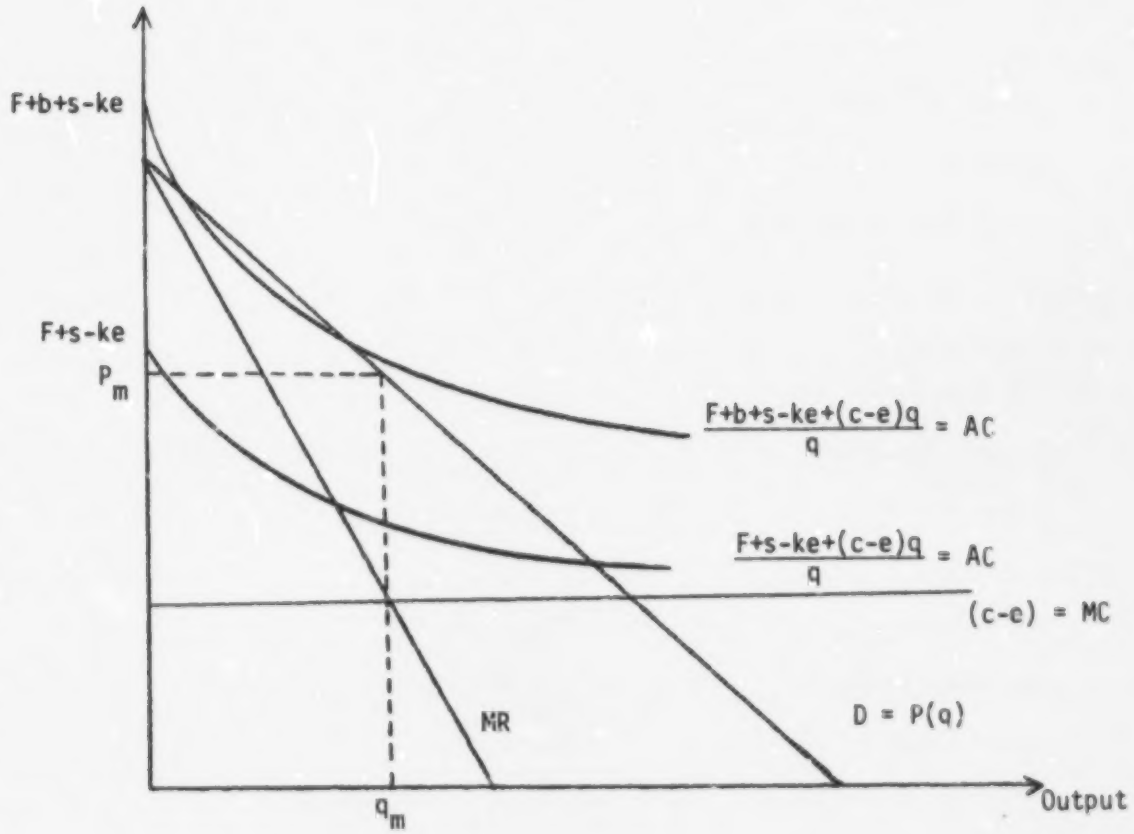

F+b+s-ke
F+s-ke
P_m
$\frac{F+b+s-ke+(c-e)q}{q}$ = AC
$\frac{F+s-ke+(c-e)q}{q}$ = AC
(c-e) = MC
MR
D = P(q)
Output
q_m

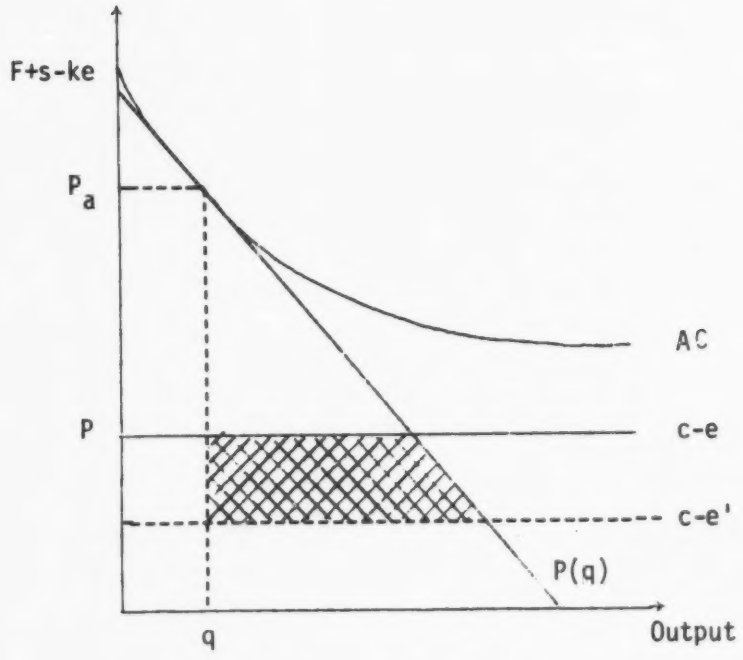
Figure 4-2

consumers are worse off. Other resources are employed in place of managerial effort so both fixed and marginal costs rise, leading to a higher price.

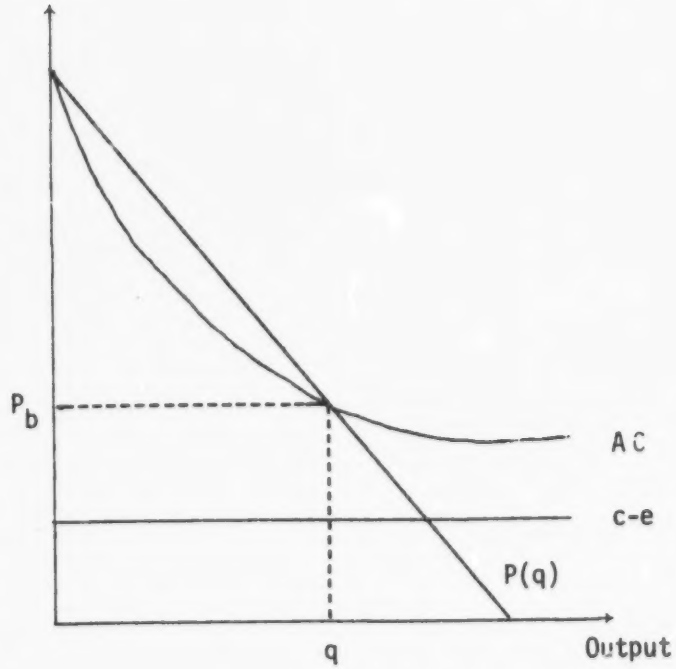
Auditing which enforces an absolute maximum on the manager's ability to appropriate b is simply equivalent to an increase in s and elimination of b. The result is to decrease e to the minimum feasible while still covering costs, or to the point where the marginal disutility of effort is zero. These cases are depicted in Figures 4-3a and 4-3b respectively. Where the marginal disutility of effort is zero, prices may be set greater that P_b, if the manager wishes to show a profit. Note that $P_a \geq P_m$. The price and cost are higher in the no perks public corporation than in the corresponding private monopoly (assuming no agency costs for the private monopoly), or the unlimited perks case of the public corporation.

Social welfare is clearly not maximized under either of these circumstances. If distributional effects and distortions due to taxes are ignored, it is well established that a social welfare maximum requires price equal marginal cost. As average cost is falling in our example, marginal cost-pricing requires a subsidy to cover the shortfall between average and marginal cost. However, the availability and form of such a subsidy will have significant effects on management behavior. In the absence of sufficient knowledge by the government, it is not easy to derive an appropriate subsidy.

If managerial effort is ignored, there are a variety of schemes which will induce the firm to follow marginal cost-pricing while producing at minimum cost. The best of these is the incremental surplus subsidy scheme, proposed by Sappington and Sibley (1984), which requires very little information from the government beyond an estimate of the



[a]



[b]

Figure 4-3

elasticity of demand and the corporate rate of discount, and observations on past costs. The scheme allows the firm complete freedom in price and cost choice and awards the firm a subsidy (assuming linearity of demand) defined as:

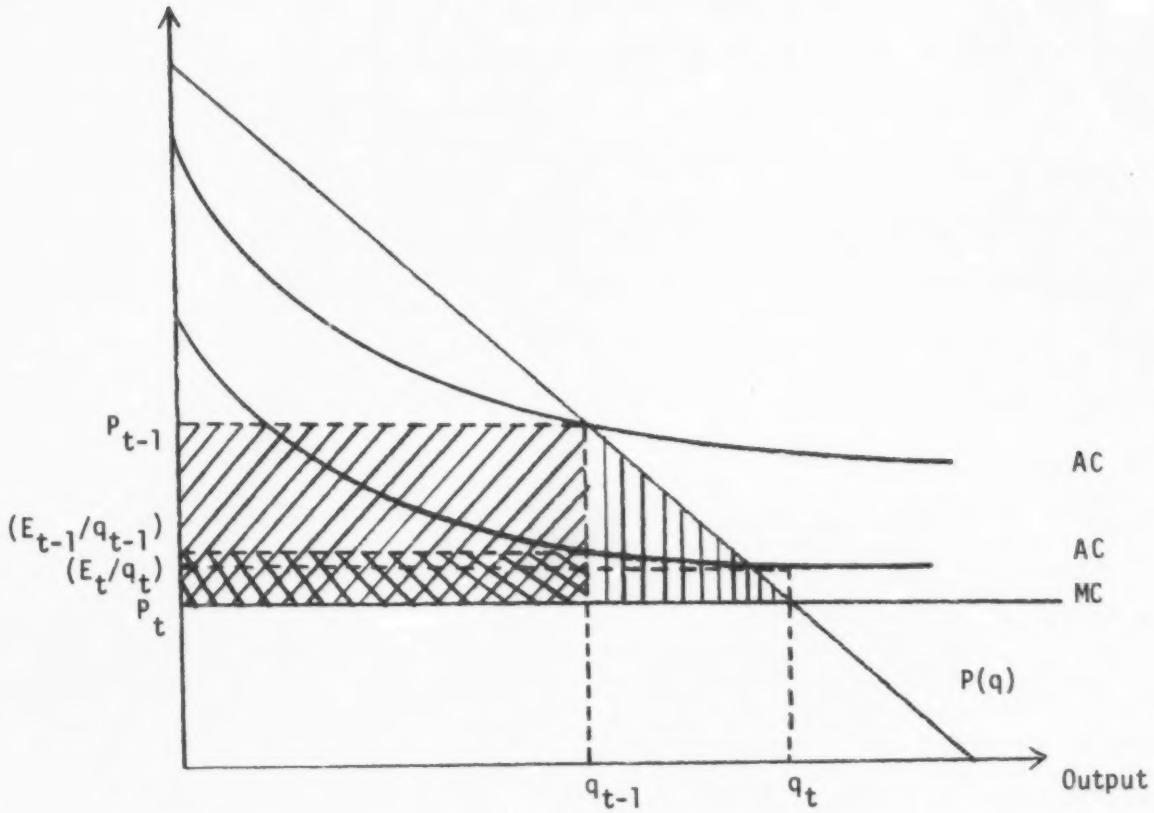
$$(4\text{-}5) \qquad S = -\Delta P_t \Delta q_t/2 + \Delta P_t q_{t-1} + E_{t-1} - P_t q_{t-1}$$

where Δ refers to the change in the variable from one period to the next and E is total expenditure. Sappington and Sibley show that the scheme will induce firms to price at marginal cost in all periods, operate at minimum cost and minimize the excess profits and, hence, the subsidy required.

The scheme basically amounts to a subsidy equal to the gain in consumer's surplus, $(-\Delta P \Delta q/2)$ due to price changes, coupled with a 100 per cent tax (subsidy) on past profits (losses). This can be seen from Figure 4-4 where the elements of equation (4-5) are indicated by 1, 2, and 3 respectively.

If the firm moves to $P_t q_t$ from $P_{t-1} q_{t-1}$, they receive a subsidy of (1) and are taxed (2)-(3). If they remain at $P_{t-1} q_{t-1}$; they are still taxed (2)-(3). So it pays to move. In the next period, the firm remains at $P_t q_t$ and receives a subsidy of $E_t - P_t q_t$ to cover its losses. It does not pay the firm to move again.

However, in the presence of managerial effort this scheme may or may not yield the desirable results but the costs may be prohibitive. If unlimited perks are possible, $E_t = P_t q_t$. Observed costs always exhaust revenue so the tax on profits is inoperative. The availability of the subsidy makes managerial rewards (s + b) an increasing function of output leading to greater effort. As total and marginal costs at t-1 are



(1) = ||| = $\Delta P_t \, \Delta q_t/2$; (2) = /// = $\Delta P_t q_{t-1}$; (3) = XX = $E_{t-1} - P_t q_{t-1}$.

Figure 4-4

observed, the government can infer the shape of the cost curve so it must remain unchanged at AC' in Figure 4-4. A move to $P_t q_t$ will now be profitable as (1) will be received by the manager but (2)-(3) = 0 in the first period. As AC' is covered by a subsidy in subsequent periods, the move leaves b unchanged in future periods but the subsidy required may be very large. Moreover, the temporary subsidy may induce some additional effort by the manager, reducing marginal cost and price, but as the subsidy is received for one period only, while effort must be expended permanently, the increase in effort is small. In the long run, there will be a tendency for observed fixed costs to drift upwards, unless strict controls are instituted by the government. Note that the system thus becomes very similar to that proposed by Vogelsang (1983) with the same undesirable distributional consequences.

If limits on perks are effective, the scheme will successfully induce marginal cost-pricing at a somewhat enhanced level of effort, but the level of effort will still fall considerably short of the optimal level. This can be seen by considering Figure 4-3a. A move from P_a to P = c-e is desirable, as managers receive $\Delta P_t \Delta q_t/2$, with future subsidy offsetting losses. As well, since benefits depend on ΔP in a non-linear way, there is increased incentive to exert effort in order to reduce marginal costs, and hence, price. For example, a decrease in original costs to (c-e') in Figure 4-3a yields increased remuneration equal to the cross hatched area. In our model, as effort affects fixed and variable costs in a fixed way, this increased effort will also reduce fixed costs reducing the subsidy. However, the managerial effort is still sub-optimal, because the marginal value of the variable and fixed cost savings exceeds the marginal benefits to manager, who receive only part of the variable cost savings

due to their effort and none of the fixed cost saving. Moreover, under the scheme, managers receive the incentive only in the initial period, while effort must be exerted in future periods as well. Thus, the present value of the cost savings far exceeds that of the managerial reward with consequently minimal effects on effort. Another problem is that effort may be diverted from fixed to variable cost savings, if possible, distorting the production structure of the firm towards high fixed costs and low variable costs. An incentive is present to convert variable costs into fixed costs even without exerting effort leading to prices which are too low and increased subsidies.[14] Thus, unless the mechanism is supported by an appropriate auditing and capital budgeting procedure, significant problems may arise. We shall come back to this question.

The issue of length of managerial tenure is also important. The scheme works most effectively when managerial tenure is relatively short, because managers receive a significant portion of the cost savings and efficiency improvements over their tenure, whereas observations on their cost and prices enable the government to set standards for their successors without excessive subsidies. As the length of tenure of managers increases it is increasingly necessary to compensate them over a longer period for any cost and price improvements, to the extent that the maintenance of reduced costs requires continuing effort.

In conclusion, it appears that the Sappington-Sibley mechanism, coupled with appropriate auditing procedures, is likely to improve the operation of natural monopolies, both in terms of optimal pricing and increased effort, but the effects on effort may well be small, unless very large subsidies and perks are allowed.

Further insight into the problem may be gained by considering the more formal agency theory. Laffont and Tirole (1984) have analyzed a model similar to that described by equations (4-1) through (4-4) for a public corporation supplying a public good. Allowing managers to receive all excess of revenue over costs eliminates the need to disguise income as cost and enables the government to utilize past cost information. However, to achieve any results, stronger informational requirements are necessary. The government is assumed to know the utility function of the managers and have information (or beliefs) on basic fixed costs F which can be summarized in the form of a Bayesian probability distribution. A reasonable assumption is that F is uniformly distributed between F and $\underline{F}$. The greater the gap between F-$\underline{F}$, the greater is the government's ignorance. The optimal incentive mechanism (managerial reward scheme) is then one which would maximize the government objective function, inducing the manager to expand appropriate effort on the basis of the true value of F, known to the manager. If distributional considerations are not important, the reward scheme will award the full consumer surplus to the manager. This is equivalent to the Vogelsang scheme.

However, distributional considerations are important for two reasons. First, a large subsidy is required. Such a subsidy is not costless; raising the revenue necessary to finance the subsidy entails economic distortions and political costs. Second, the award of very high remuneration to public corporation management transfers all the rents to them, leaving the public no better off. It is therefore necessary to discount (possibly very heavily) transfers to managers in the calculations of social welfare, and to multiply the cost of the subsidies by a factor greater than one in the welfare calculations.

The government must then determine an incentive scheme consisting of a subsidy to the public firm to cover any losses and to compensate managers, in such a way as to induce managerial effort as well as low prices at minimum sbusidy costs.

The objective function is then,

$$\text{(4-6)} \qquad \text{Max} \int_{\underline{F}}^{\overline{F}} [CS - (1 + \lambda)(TC - Pq) + s - g(e)]dF$$

i.e., the expected value of consumers' surplus less subsidies evaluated at a cost of $1 + \lambda > 1$ plus managerial welfare, where s is a compensation scheme for the managers, which would determine managerial effort and prices.

Such a scheme is generally quite difficult to obtain except for the simplest forms of managerial utility and firm cost functions, and requires precise information about managerial utility and productivity functions, which are not likely to be known. Moreover, when more than one parameter of the cost function is unknown, implementation is only possible by numerical methods. It is therefore clear that operationally optimal schemes are not possible. However, linear compensation schemes may yield reasonable approximations to the optimal solution, so we may gain insight into the problem by investigating their properties.

In general, linear compensation schemes for the problem specified take the form of a fixed subsidy to the firm, related to consumers surplus, on the basis of $\overline{F}$ and its estimated cost parameters plus a partial reimbursement of the actual excess of costs over revenues. The proportion reimbursed depends on g(e) and is inversely related to λ. Because only part of the losses are reimbursed, firms will generally charge a price higher than marginal cost to reflect the high cost of the subsidy. As well, managerial effort will fall short of that of a private monopolist or the unlimited perks case. This is because managers only receive part of

any cost savings due to their effort. Risk aversion by managers will further contribute to partial cost reimbursement and hence lower effort. Note that the initial payment falls as F falls. Thus, auditing to reduce government uncertainty reduces the subsidy required to keep managers honest.

A second general result of the agency theory is that if e is imperfectly observed, perhaps through a post-decision performance audit, an optimal compensation scheme will also consist of discrete penalties for poor effort - in particular performance which falls below a minimum level will be punished by firing. This combination of monitoring and penalties is particularly important in view of the very strong job security in the public sector. In the private sector, bankruptcy automatically leads to loss of job. However, in the public sector, bankruptcy is not generally allowed. Therefore, an established procedure for the determination of grounds for firing must be implemented.

The problem of possibly inadequate performance due to lack of effort is compounded by the problem of managerial selection. If the wrong manager is appointed, effort may well be irrelevant. Thus, managerial selection is extremely important. Remuneration structures are extremely important in executive selection, because they induce managers to self-select, i.e., to apply for those positions in which, given their quality, they will do best. Thus, a remuneration scheme which involves a small base salary but large performance bonuses for performance above a certain standard, will generally attract only those individuals confident in their ability to meet the performance standards.[15] In contrast, a fixed salary will attract low ability applicants. Firing, however, for inadequate performance may eliminate the worst applicants, but will not eliminate mediocre ones. Hence, performance based remuneration structures are desirable in order to

attract high quality ones.

Another advantage of such skewed reward schemes is that they repel risk averse managers. As we have seen, risk aversion by agents makes it attractive for the principal to insure them by sharing risks. However, such increased risk sharing by the principal reduces the incentive to perform and supply effort. For example, in the natural monopoly analyzed earlier, higher risk aversion leads to a larger reimbursement of losses in the optimal scheme, leading to a higher price and lower effort.

Steep remuneration schemes, moreoever, may partly mitigate the problem of political patronage appointments to the management of public corporations. Such positions would no longer be attractive to unqualified political appointees. However, they are unlikely to eliminate them altogether. In order to minimize such appointments, a system of vetting is necessary for appointments to top managerial positions in Crown corporations. Such vetting may be done by a parliamentary committee in conjunction with expert panels.

A problem of steep and non-linear remuneration scales arises due to risk considerations. Where outcomes are subject to random effects outside the control of the manager, steep remuneration schedules involve considerable risk. Thus, they may attract risk lovers. Moreover, because risks are assymetric, incentives are created for excessive risk taking. If successful, the rewards to the managers are high, but if unsuccessful, the manager may lose his/her job. However, the damage imposed on the corpration is considerably greater than the cost of firing to the manager. The situation is similar to that of the incentive for borrowers to invest in high risk ventures unless they share significantly in the risk.[16] Firing mitigates this problem, but does not eliminate it. Thus, pre-decision

controls must be instituted with respect to projects which involve large investment. If funds are raised by the Crown corporation on the bond market, lenders are likely to scrutinize such investments carefully and the risk will be reflected in the cost of borrowing. However, to the extent that the market perceives an implicit government guarantee against bankruptcy, such external controls are weak. Thus scrutiny and approval of capital budgets and long term plans by the Treasury Board or another appropriate agency is necessary.

Finally, reward schemes must take account of the length of service of managers. It is generally extremely difficult to evaluate potential future long term effects of policies. It is much easier to evaluate past events. Therefore, remuneration schemes must be inevitably related to past performance rather than to future potential. Where managers expect to remain in their positions for a long time, this is not important. Policies will be undertaken to improve long run performance in the knowledge that the rewards will accrue to the manager in the future. However, when managerial tenure is short or uncertain, as is the case for politicians, efforts will be diverted from more productive long term projects to those which yield short benefits. In private corporations, stock values are likely to reflect such future long term benefits-though imperfectly. Thus, some mechanism for evaluation of future benefits is necessary, where managerial tenure is likely to be short - e.g., when top managers are close to retirement. Because of the difficulty of assessing such performance, it is perhaps best to reward departed managers in some fashion after retirement perhaps in the form of bonuses for past performance.

5.0 Economic Contests as Internal Control Mechanisms in Public Corporations

Interest in the role of competition as an incentive device has been rekindled during the past couple of years. The initial work of Lazear and Rosen (1981) and Stiglitz (1980) together with much of the work that followed (e.g. Green and Stokey (1981), Homstrom (1982), Nalebuff and Stiglitz (1983), and Malcomson (1984), among others) has been concerned with the circumstances in which rewards based upon relative output are superior to payments based on individualistic output (i.e. piece rates or quotas). In contrast to this direction of analysis, O'Keefe, Viscusi and Zeckhauser (1984) take the contest form as given, for any of the reasons suggested in the work by the previous authors and, instead, question the properties that we should expect to observe in a contest and how contests can be conducted to achieve the best feasible outcomes. The authors conclude that contests may be valuable in yet another domain, enticing the right people to "play the game". Through a judicious trade-off between monitoring and the size of the prize with separate tournaments, the authors find that individuals of the appropriate quality can be self-selected into the correct contest.

Similar to O'Keefe, Viscusi, and Zeckhauser, our focus is also on the design of contests to encourage certain patterns of behavior. Unlike O'Keefe, Viscusi, and Zeckhauser, however, the monetary prize for winning in our model is associated directly with a job promotion to the supervisory level.

Generally, contests which award specific monetary prizes are common in areas where measurement of output is relatively easy (e.g. salesmen's compensation). However, in most situations where output measurement is difficult and possibly subject to arbitrary elements--as is the case in bureaucracies

and team production, prizes are offered in the form of promotions. These are the main incentive mechanisms used in public corporations. The incentive effects of promotion, moreover, depend not only on the size of the prize--the managerial salary, but also on the number of supervisory positions. However, supervisors do have a productive role. Thus the number of supervisors has a dual role in creating incentives to lower echelon workers on the one hand, and in enhancing their productivity on the other. Similarly, the size of the prize, the supervisory salary, creates an incentive for the lower echelons, but increases the cost of supervision.

As the measurement of output is particularly difficulty in public corporations, promotions appear to be the main incentive mechanism used within these firms and the civil service. Therefore these interactions are particularly important. As well, political considerations may impose serious restrictions on the size of monetary rewards, whether associated with promotion or not. These may take the form of lower limits to remuneration of workers or upper limits on prizes or remuneration of supervisors. Thus public firms may have to offer smaller but more numerous prizes to maintain incentives, leading to greater supervision and possibly top heavy structures.

We propose therefore to explore the structure of such promotion contests in order to identify the costs and limitations of such contests as internal incentive mechanisms within public corporations and their possible adaptation as external incentive mechanisms for relevant classes of public corporations.

To analyze the problem, we consider a very simple two period-two tier overlapping generations model of employment structure. The firm is assumed to be an ongoing entity, but employees are assumed to work for two periods only. N employees are hired at the beginning of each period at a fixed wage of m_1

independent of their productivity. At the end of this period their performance is evaluated and a proportion k are promoted to supervisory positions, while $1-k$ continue as workers for the second period at a wage of m_2. All workers and managers retire at the end of the second period. Thus at any point in time following the first period the firm employs $2N$ workers of which a proportion $k/2$ are supervisors, all of whom were internally promoted. Supervisory salaries, $M > m_2$, thus constitute prizes to be competed for by first period workers through increased effort (z).

Defining units of effort and output appropriately, without loss of generality, we may define the relation between workers' output (q) and effort (z) as:

$$q_{ij} = z_{ij} + e_{ij} \tag{5-1}$$

where $i = 1,2$ designates the period and $j = 1,\ldots,N$ designates the individual. The variable e_{ij} is assumed to be a normally distributed random variable with mean 0 and variance σ_i^2, where e_{ij} is independent of e_{ik} for all $j \neq k$. e_{ij} may be interpreted as a random variable affecting output, where effort is measured by output. Alternatively, the measurement of performance may take the form of observations on effort because output cannot be easily evaluated but is known to be determined by the effort level. If actual effort can only be measured with an error, it follows that e_{ij} in (5-1) can be interpreted as the measurement error and q_{ij} as the measured level of effort. Because in public corporations outputs are not easily observed, performance measurement must frequently rely on measurement of inputs, so that the latter interpretation of (5-1) may be relevant. The analyses developed in this section follows directly from either interpretation of the error in measuring performance.

Suppose now that there are kN prizes (supervisory positions) available. Those employees promoted will be the kN employees with the highest output. Hence, the probability of the j-th employee winning in period 1 (p_{1j}) depends upon the number of available positions, his output, and the output of each of his competitors. That is,

$$p_{1j} = p_{1j}(k, q_{11}, q_{12}, \ldots, q_{1N}) \tag{5-2}$$

Assuming workers play a Nash game and that everyone is equal, we may express the probability of promotion for the j-th worker as:

$$p_{1j} = kp(z_{1j}, z_1, \sigma_1^2, N) \tag{5-3}$$

where z_1 is the effort level of all other first period workers. That is, the probability of the j-th worker being promoted is equal to the probability that someone will be promoted (k) times the probability that the j-th individual will be promoted given someone is promoted (p).

Workers are assumed to determine their effort to maximize their expected life-time utility, which is assumed to be additively separable in income and effort.

$$U_{ij} = U(y,z) = y_{ij} - U(z_{ij}) \qquad U', U'' > 0, \quad z \geq 0 \tag{5-4}$$

where y_{ij} is worker j's money income in period i and $-U(z_{ij})$ is his disutility of effort. Over his working life, each worker faces a two period expected utility function in which he chooses his optimal level of effort to supply. Ignoring the time discount, we have:

$$\underset{z_{1j}, z_{2j}}{\text{Max}} \; E(U_{1j}+U_{2j}) = m_1 + kp(z_{1j}, z_1, \sigma_1^2, N)M + [1 - kp(z_{1j}, z_1, \sigma_1^2, N)]m_2 - U(z_{1j}) - U(z_{2j}) \tag{5-5}$$

where z_{ij} is the average effort exerted by worker j in period i.

As the model stands, because there are no rewards to second period effort, it is clear that no effort is supplied in this period. There are two choices here. We may introduce prizes in the second period or we may specify a mechanism to yield a given effort level in period 2. The second course simplifies the analysis considerably, enabling us to focus more clearly on the nature of supervision and incentives, so we shall follow it here.

To understand the supply of effort in this context we must determine clearly the role of supervisors. Supervisors may be assumed to perform two kinds of duties. First, they may enhance the productivity of individual workers by coordinating and directing their actions. The level of supervision may thus be treated as a complementary factor of production to effort in the production function. As well, supervision involves monitoring of output or inputs. The latter activity results in reduction of the measurement errors associated with performance. Because monitoring is closely associated with the nature and efficiency of the contest, we have chosen to high-light this function of supervision.

The variance of the measurement error (σ_i^2) with monitoring is thus assumed to be a function of the level of supervision in each period and the variance of the measurement error without monitoring (σ^2), or

$$(5\text{-}6) \quad \sigma_1^2 = \sigma^2/f(k_i) \qquad f' > 0 \ , \quad f'' < 0 \ ,$$

where k_i is the ratio of supervisors to workers in period i.
We assume that there exists an inferior production technology which involves higher levels of supervision, coupled with a more rigid production structure such that with supervision level $\bar{k}$ and effort $z_2 \leq \bar{z}_2$, $\sigma^2/f(\bar{k}) = 0$, i.e.

a sufficient level of monitoring error variance is reduced to zero. Hence, for workers in period 2, supervisors are able to insure a level of effort $z_2 = \bar{z}_2$. Therefore, the level of m_2 is determined by the reservation utility of workers in period 2, $\bar{U}_2 = m_2 - U(\bar{z}_2)$. Assuming that the level of effort of supervisors is the same as other period 2 workers ($\bar{z}$), we may rewrite equation (5-5) as:

$$(5\text{-}7) \quad \max_{<z_{1j}>} E(U_{1j}+U_{2j}) = m_1+kp(z_{1j},z_1,\sigma_1^2,N)(M-m_2)-U(z_{1j})+\bar{U}_2$$

The first order condition for optimal effort supply in period 1 is then:

$$(5\text{-}8) \quad k\ \partial p/\partial z_{1j}(M-m_2)-\partial U/\partial z_{1j} = 0 \ .$$

As all workers are assumed equal in all aspects, equation (5-8) must be evaluated at the symmetric equilibrium $z_{1j} = z_1$. Given our assumptions about the nature of the errors, the marginal probability can be written as:

$$(5\text{-}9) \quad \partial p/\partial z_{1j} = h(N)f(k_1)[2\pi^{1/2}\sigma]^{-1} = \bar{g} \ , \quad \text{where } h' > 0.$$

The increase in probability of winning a supervisory position, as represented in (5-9), is a positive function of the sample size (N) and the level of supervision (k_1), and is inversely related to the standard deviation of the measurement errors (σ). Substitution of (5-4) into (5-8) yields a simpler expression for the optimal effort level:

$$(5\text{-}8a) \quad k\bar{g}(M-m_2) = U'$$

Equation (5-8a) states that the marginal expected benefit from an increase in effort in period 1 must just equal the marginal disutility of the effort, evaluated at the symmetric effort equilibrium. It is clear from

equation (5-8a) that the level of effort depends on the expected value of the prizes offered $k(M-m_2)$, as well as on the precision of effort measurement ($\bar{g}$), which in turn depends on the degree of supervision. Because the disutility of effort is increasing in effort ($U'' > 0$), the optimal level of effort may be written explicitly as:

$$z_1^* = z_1(k,\bar{g},M-m_2) \quad . \tag{5-10}$$

Given the workers decisions on effort (z) in the two periods, the firm's problem is to minimize expected costs per unit of output from the two generations of workers employed during any period, by choosing the control variables M,m_1, and k_1, subject to a number of additional constraints. As we have seen, because no prizes are available to the firm at the end of period 2, supervision must be set high at $k_2 = \bar{k}$. Two additional constraints arise from external recruitment considerations. Given the compensation schemes which determine effort in both periods, the firm's remuneration/effort package must be competitive--that is it must supply a level of expected utility for either period which at least matches that available elsewhere. As we have seen before, for period 2 workers this implies:

$$m_2 - U(\bar{z}_2) = \bar{U}_2 \quad . \tag{5-11}$$

Period 1 workers must consider both periods in deciding whether to join the firm. Define their reservation expected utility as $\bar{U}_1$, then

$$m_1 + kM + (1-k)m_2 - U(z_1^*) - U(\bar{z}_2) \geq \bar{U}_1 \quad . \tag{5-12}$$

Subtracting equation (5-11) from inequality (5-12), we have:[17]

$$m_1 + k(M-m_2) - U(z_1^*) \geq \bar{U}_1 - \bar{U}_2 \quad . \tag{5-13}$$

An additional constraint, which is introduced (due to the workers' risk neutrality assumption) is:

$$(5\text{-}14) \qquad m_1 \geq \bar{m} \ .$$

This may reflect a subsistence level of income in the first period, minimum wage laws, etc.

As product price and the number of employees are assumed to be fixed it is convenient to solve the firm's problem as an expected surplus maximization problem:

$$(5\text{-}15) \qquad \underset{<m_1,M,k_1>}{\text{Max}} \quad S = vz_1^* + v(1-k)\bar{z}_2 - m_1 - (1-k)m_2 - kM$$

$$\text{Subject to} \quad \text{(i)} \quad m_1 + k(M-m_2) - U(z_1^*) \geq \bar{U}_1 - \bar{U}_2$$

$$\text{(ii)} \quad m_1 \geq \bar{m}$$

$$\text{(iii)} \quad z_1^* = z_1(k,\bar{g},M-m_2)$$

where S is surplus per first generation worker, and v is the product price.

Note that the number of second generation workers is $(1-k)N$, as supervisors are drawn from their ranks. Hence $\bar{k} = (k-k_1)/(1-k)$ and solving for k yields:

$$(5\text{-}16) \qquad k = (k_1+\bar{k})/(1+\bar{k})$$

Substituting (5-16) into (5-15) we may form the Langrangian function:

$$(5\text{-}17) \qquad \underset{<k_1,m_1,M>}{\text{Max}} \quad L = vz_1^* + v\left(\frac{1-k_1}{1+\bar{k}}\right)\bar{z}_2 - m_1 - \left(\frac{1-k_1}{1+\bar{k}}\right)m_2$$

$$- \left(\frac{k_1+\bar{k}}{1+\bar{k}}\right)M + \lambda_1\left[m_1 + \left(\frac{k_1+\bar{k}}{1+\bar{k}}\right)(M-m_2) - U(z_1^*) - \bar{U}_1 + \bar{U}_2\right] + \lambda_2(m_1 - \bar{m}_1)$$

The first-order conditions associated with this problem are then:

(5-18a) $$\frac{\partial L}{\partial k_1} = v\left(\frac{\partial z_1^*}{\partial k_1} + \frac{\partial z_1^*}{\partial \bar{g}}\frac{d\bar{g}}{dk_1}\right) - \left(\frac{v\bar{z}_2 - m_2 + M}{1+\bar{k}}\right)$$

$$+ \lambda_1\left[\frac{M-m_2}{1+\bar{k}} - U'\left(\frac{\partial z_1^*}{\partial k_1} + \frac{\partial z_1^*}{\partial \bar{g}}\frac{d\bar{g}}{dk_1}\right)\right] = 0$$

(5-18b) $$\frac{\partial L}{\partial m_1} = -1 + \lambda_1 + \lambda_2 = 0$$

(5-18c) $$\frac{\partial L}{\partial M} = v\frac{\partial z_1^*}{\partial M} - \left(\frac{k_1+\bar{k}}{1+\bar{k}}\right) + \lambda_1\left(\frac{k_1+\bar{k}}{1+\bar{k}} - U'\frac{\partial z_1^*}{\partial M}\right) = 0$$

(5-18d) $$\frac{\partial L}{\partial \lambda_1} = m_1 + \left(\frac{k_1+\bar{k}}{1+\bar{k}}\right)(M-m_2) - U(z_1^*) - \bar{U}_1 + \bar{U}_2 \geq 0 ;$$

$$\lambda_1\left[m_1 + \left(\frac{k_1+\bar{k}}{1+\bar{k}}\right)(M-m_2) - U(z_1^*) - \bar{U}_1 + \bar{U}_2\right] = 0$$

(5-18e) $$\frac{\partial L}{\partial \lambda_2} = m_1 - \bar{m}_1 \geq 0 ; \quad \lambda_2(m_1-\bar{m}_1) = 0$$

(5-18f) $$k_1, M \geq 0$$

Looking to the conditions in (5-18e), either $\lambda_2 = 0$ or $m_1 = \bar{m}_1$. Suppose $\lambda_2 = 0$. It follows from (5-18b) that $\lambda_1 = 1$ which when substituted into (5-18c) implies that $v = U'$. Direct substitution of these values for λ_1 and U' into (5-18a) yields the inconsistent result that $\frac{v\bar{z}_2}{1+\bar{k}} = 0$. Hence, by contradiction, the optimal base salary m_1^* is the minimum salary $\bar{m}_1$ and $\lambda_2 > 0$. It should be recognized that the tradeoff between a greater prize and a lower base salary within the model which results in a preference for the former, is a direct effect of our assumption that workers are risk-neutral.

It will likely be the case, for risk-averse individuals, that a more secure, higher base salary is preferred.

With $\lambda_2 > 0$, the worker's reservation utility constraint may or may not be binding, i.e., $\lambda_1 \geq 0$. If, for example, $\lambda_1 = 0$, the implication is that the firm is paying its workers more than their reservation utility. Provided the extra reward induces greater effort and, hence, greater surplus to the firm, there is no reason to reduce the compensation package to the floor level dictated by the reservation utility. In so far as $\lambda_1 > 0$, however, the reward package yields an expected utility to workers exactly equal to their reservation utility. In this situation, the cost to the firm of increasing the reward exceeds the benefit from any increased effort so that the minimum reward package is offered to maintain the workers in the firm.

From condition (5-18c), the size of prize M is determined by setting its marginal benefit equal to its marginal cost. By increasing M the benefit to the firm is its incentive effect upon the level of effort undertaken while the marginal cost is simply the incremental salary paid to all supervisors. Because the additional effort induced by a higher reward has a disutility associated with it, an even greater M is required to also compensate for this secondary effect. The $\lambda_1(\cdot)$ expression represents this indirect influence on the optimal size of M.

If we now solve (5-18c) for λ_1 and substitute the result into (5-18a), the factors influencing the choice of k_1 are readily apparent.

$$(5\text{-}19) \qquad v\left[\frac{\partial z_1^*}{\partial k_1} + \frac{\partial z_1^*}{\partial \bar{g}}\frac{d\bar{g}}{dk_1}\right] + \left[\frac{v\frac{\partial z_1^*}{\partial M} - \left(\frac{k_1+k}{1+\bar{k}}\right)}{U'\frac{\partial z_1^*}{\partial M} - \left(\frac{k_1+\bar{k}}{1+\bar{k}}\right)}\right]\left[\frac{M-m_2}{1+\bar{k}} - U'\left(\frac{\partial z_1^*}{\partial k_1} + \frac{\partial z_1^*}{\partial \bar{z}}\frac{d\bar{g}}{dk_1}\right)\right]$$

$$= \frac{1}{1+\bar{k}}\left[v\bar{z}_2 + M - m_2\right]$$

Equation (5-19) is again a marginal benefit-marginal cost prescription for optimal behavior. The marginal benefit in this case is composed in part of the first expression on the L.H.S. which represents the marginal value to the firm of an increase in k_1 due to the effect of such a policy on effort. The two-pronged effect of additional supervisors on the level of effort is composed of an additional incentive influence and increased monitoring which reduces the error in measuring actual effort. Both factors increase effort. The second expression on the L.H.S. of (5-19) is an indirect benefit associated with more supervisors. As k_1 increases, the magnitude of salary paid to each supervisor can be decreased and yet the firm can still maintain the worker at his reservation utility level, once the disutility of effort associated with greater supervision is accounted for. The marginal costs of increased supervision, as expressed by the R.H.S. of equation (5-19) is composed of two parts. Each additional supervisor must be paid a salary of M and each additional supervisor is a converted worker whose productivity is now lost in the second period. The net value of this loss in productivity is $v\bar{z}_2 - m_2$. Because a one percent increase in k_1 is accompanied by a decrease of $\frac{\bar{k}}{1+\bar{k}}$ in k_2, the total change in promotions when k_1 is increased by one percent is only $\frac{1}{1+\bar{k}}$ which accounts for the marginal cost being weighted by this factor.

It is often the case that in public firms the salary paid to supervisors is constrained to be below the optimal level dictated in the above solution to the problem (M*). This may be purely a political consequence of employment in the public sector. In order to attract individuals to pursue careers in public firms while maintaining incentives, more prizes may be offered in lieu of larger prizes. Specifically, as M is lowered from its optimal value of M^* (holding m_1 constant), efficiency maintenance requires more prizes (greater k_1). As k_1 increases, however, the effect on optimal effort per worker, $z^* = z_1^*(1-k)$, is:

$$(5\text{-}20) \qquad \frac{dz_1^*}{dk_1} = \frac{z_1^*}{\bar{k}}\left(\frac{1-k_1}{1+\bar{k}}\right) - z_1^*\left(\frac{1}{1+\bar{k}}\right)$$

The first term in (5-20) is the effect of additional supervision on the effort of all workers not previously promoted while the second term is the loss in effort from the conversion of a productive worker to a supervisor. For a relatively small reduction in M from M^*, the corresponding increase in k_1 to provide the reservation utility to workers would be sufficient to leave m_1 at its minimum level of $\bar{m}_1$. Larger reductions in M may, however, require m_1 to increase above $\bar{m}_1$ since k_1 cannot sufficiently offset the lower value of the award. At the extreme, as M approaches m_2, the increase in k_1 alone may actually have a negative effect on additional effort (too many supervisors monitoring too few workers) so that m_1 will be raised even more with a corresponding reduction in the number of supervisors.

It is quite reasonable, therefore, to expect that when M is restricted to be below its unconstrained optimal value, both k_1 and m_1 will be above their unconstrained values. This description of behavior in public

firms coincides quite well with what we actually observe: lower salaries for managers than in private firms, more managers than in a similar private firm, and higher starting salaries than in the private sector.

In the preceding analysis we have ignored the role of N - the contest group, assuming it to be exogenous. However, even if N is exogenous, the population of first generation workers may be broken down into sub-groups. Members of sub-groups may then compete internally for the fraction of the managerial positions allocated to them. Our analysis suggests that this is a sub-optimal procedure, as the probability of promotion given superior effort is an increasing function of the sample size ($h' > 0$ in equation 5-9).

While this is difficult to prove analytically for arbitrary distributions, the logic of it may be easily explained by contrasting the two extreme possibilities.

First consider the case where first generation workers are paired. Each pair competes for a chance at a lottery for the kN managerial positions. The variance of the difference $z_1 - z_2$ is equal to twice the variance of ϵ, so that $\partial p/\partial z = f(k_1)[4\pi^{\frac{1}{2}}\sigma]^{-1}$.

At the other extreme consider the case of a firm-wide competition for the kN managerial positions, where $N \to \infty$. Here $\partial p/\partial z = f(k_1)[2\pi^{\frac{1}{2}}\sigma]^{-1}$, because only the variance of the individual's error is relevant, as errors in rivals' performance wash out in the aggregate. The greater precision in the measurement of the individual's effort therefore makes the exertion of such effort more profitable and hence induces a large amount of equilibrium effort at any level of k and M.

Another important advantage of maintaining the larger possible competitive group (i.e. firm-wide competition) arises from the fact that collusion

among workers becomes more difficult as the number of competitors increase, reducing the possibility of all workers shirking and splitting the prize. Of course, the fact that prizes are tied to supervisory positions also reduces the scope for collusion, though it does not eliminate it.

An important point which arises from our analysis is that supervisory contests are superior to purely monetary ones, in which monetary prizes are awarded independent of supervisory functions. This is because supervisors perform a productive function within the firm. An increase in the level of supervision which yields the same expected increase in the expected prize which arises from an increase in M, involves the same marginal cost to the firm but generates greater effort due to its monitoring function. Thus the ability to combine the monitoring or other productive functions of supervisors with an incentive function due to higher wages paid to supervisors, makes contests a more efficient remuneration scheme.

Previous research (e.g. Lazear and Rosen (1981), Green and Stokey (1981), etc.) has shown that pure monetary contests are generally inferior to piece rate remuneration schemes, except under special circumstances. The contest for managerial positions may be a superior instrument even when these conditions are not satisfied. Perhaps this helps explain its universal usage as an incentive device within corporations.

The preceding analysis may yield some tentative lessons for the design of incentive mechanisms in the public sector. For example, since competitive schemes are more efficient as the number of participants increases, competitors may profitably be enlarged to encompass several Crown corporations in one competitive promotion pool providing measured output is relatively homogeneous among competitors. As skills may be specialized and as the marginal gains to increases in pool size are likely to fall as pool size increases, this suggests optimal groupings of Crown corporations for this purpose.

6.0 Summary and Recommendations

The fundamental source of the control problem in any organization, public or private, is the delegation of decision making authority to one party (agent) to transact business on behalf of the other party (principal). When this situation exists and the decision-maker has relevant information unknown to the principal (asymmetric information) together with diverse preferences (usually represented by diametrically opposed views about the optimal level of effort to be undertaken by the agent), the need for control mechanisms of one form or another arises.

Though the principal-agent relationship occurs throughout society, the democratic system of government, in particular, highlights the costs associated with these relationships and need for the principal to implement control mechanisms. A democractic representative government is ultimately responsible to the voters and thus may be presumed to operate in their best interests. However, the short run interests of the government of the day may, at least temporarily, diverge from the long run interests of the voters in particular directions, which may affect the policies of public corporations and divert them from pursuing the long run public interest. At the same time, under the democratic system, only the crudest of instruments are available for curtailing the ability of the party in power from extracting rents as they administer the operations of a variety of public corporations scattered throughout the economy. The crude instrument referred to is voting the incumbent party out of power which is equivalent to firing in the private sector. If this is the only available mechanism and the employer, for example, sets a standard such that workers who perform better than the standard continue to be employed while those falling below the standard are fired, those workers who strive to meet the standard barely do so, with little "wasted" effort expended to achieve outstanding performance.

At the same time, those workers who know they cannot satisfy the standard (e.g., low ability workers), exert no effort. Hence, the distribution of performance is very inefficient - lower ability workers exert no effort while higher ability workers exert the minimum level of effort to meet the standard. In the political arena, where the electoral controls are equivalently crude, there is a tendency for the distribution of effort to be similarly inefficient suggesting strongly the need for alternative control mechanisms.

In determining the form and degree of appropriate delegation of decision making authority within public corporations, it is particularly important to evaluate the specific goals of the firms in question and the nature of the information which is likely to be available at reasonable cost to the relevant parties--the public at large, parliament, the responsible minister and the corporate management.

Integrally related to the problem of organizational goals and the delegation of decision making power is the question of information availability. Because information allows the decision maker to overcome uncertainty and, hence, make "better" decisions, ceteris paribus, the party with more information should be delegated decision making authority. The degree of autonomy accorded management, however, can reasonably be expected to be a function of the stability of the goals. Thus, where a continuous reading of the public pulse is required, in order to satisfy demands which may change significantly and frequently, politicians are more likely to possess the information necessary and, hence, are more likely to retain a considerable degree of detailed control. Therefore, distributional and public goods issues which fall into this area tend to be delegated to government departments, rather than to public corporations.

As the degree of political knowledge required becomes less important, however, and the informational aspects of a technical nature gains increased significance, a greater degree of delegation is both necessary and desirable. Thus, where organizational goals can be defined in a consistent way, and where these goals are relatively stable over time, a public corporation may be the more appropriate institutional structure. Since the focus of this study has been with information of a technical variety, our concentration has, therefore, been on the institutional arrangements (primarily public corporations) appropriate for dealing with these considerations.

We must keep in mind, however, that the delegation of authority is not without its costs, those being the negative externalities that may be imposed by one party on another because of the informational asymmetries present in the economic relationship. In deciding the degree of delegation one must not overlook the costs of overcoming the informational asymmetries. These costs will also aid in the definition of both the nature of performance monitoring and the level of pre-decision monitoring undertaken within the firm.

Efficient performance monitoring requires two instruments: (a) low cost and low error monitoring devices; and (b) effective reward and punishment mechanisms. These are complements, in the sense that monitoring without appropriate rewards or punishments is not likely to lead management to follow the desired goals or devote sufficient effort. However, efficiently designed reward mechanisms may be a good substitute for monitoring to the extent that they succeed in eliminating conflicts between the organizational goals and the interests of management. In the private sector this is exemplified by tying executive remuneration to stock market performance and in so doing, executive and shareholder interests are made mutually consistent which in turn reduces the degree of required monitoring.

While ideally an incentive mechanism might be designed to induce the optimal effort by executives of public corporations, the available mechanisms suffer from problems of equity distribution so as to make them unattractive from a practical standpoint. Hence, what is needed is a second-best reward/punishment scheme complemented by monitoring.

In many situations, moreover, the problems in a public corporation do not differ significantly from those of private corporations, so that successful organizational forms and internal incentive structures may be safely borrowed from the private sector. Hence, we have examined the principal alternative to a public corporation, regulated private firms, to identify incentive structures that might be effectively applied to the public firm. While the literature is replete with incentive schemes to motivate managers of regulated firms, all fall short of providing an equitable mechanism capable of inducing optimal intertemporal behavior and, hence, are deficient mechanisms for practical application in either the private or public sector. It appears, therefore, that greater reliance upon control efforts using an expanded purview of the Auditor-General is necessary in view of the limited practical role for reward-based schemes in the public sector.

6.1 Recommendations

The analyses undertaken in this study has lead to a number of recommendations which are intended to improve upon the control of Crown corporations in Canada.

Recommendation 1: The objectives of Crown corporations should be clearly specified and where possible, algorithms should be developed to provide an unbiased process of evaluation.

The stock market provides an unbiased evaluation of managers in the private sector and while this control mechanism is unavailable in the public sector, algorithms, perhaps unique to the firm, should be designed, where possible, to reflect a similar unbiased evaluation of performance.

Recommendation 2: The role of the Auditor-General should be expanded.

While the Auditor-General must not second guess political judgments, it is necessary that his role be expanded to investigate the way in which such political judgment is executed. Thus, given the goals set forth by the designated minister, the Auditor-General should evaluate the efficiency of actions undertaken to further these goals.

Recommendation 3: The government guarantee of a Crown corporation's debt should be eliminated.

While it has often been argued, on grounds of resource allocation inefficiency, that the guarantee of Crown corporations' debt should be removed, another motivation for doing so is the distortion in market prices of bonds which is caused by this subsidy. In turn, because of the debt guarantee, another potential market mechanism for evaluating managers is no longer useful.

Recommendation 4: The appointment of top executives of Crown corporations should be a two-stage process. An advisory committee from the private sector should submit a list of qualified candidates to a Parliamentary committee which should then select a person from this list.

In an attempt to guarantee that qualified individuals are selected as presidents and board members of Crown corporations, an objective and knowledgable private sector advisory group should develop a list of highly skilled individuals for submission to Parliamentary review. This is the process most often followed for judicial appointments and insures that the individual ultimately selected satisfies the standards set by the profession.

Recommendation 5: The optimal control scheme within a public corporation should be a combination of penalties, rewards and monitoring mechanisms.

Within the public sector, there are restrictions on the use of markets (e.g., stock, bond, and labor) as control mechanisms as well as on the severity of penalties and indulgence of rewards. Hence, no mechanism dominates the others and what is required instead is a combination of mechanisms.

Recommendation 6: The objectives of Crown corporations should be periodically reviewed with specific reference to the need for their continuation. If renewal is no longer justified, the corporation should be sold to private interests or dismantled.

Over time, either the objectives of the firm may have changed or the effectiveness of this particular instrument may have changed which, in either case, would warrant the dissolution of the public enterprise as such. We stress, however, that if the decision is to either sell or give shares of the firm to the public, the ultimate diffusion of ownership must not be so great as to effectively eliminate the market as a disciplining force.

Footnotes

1. See Averch and Johnson (1962) and the many extensions of their work that follow.

2. When considering the privatization of a Crown corporation, there are two means to implement the decision: complete privatization or partial privatization. The choice of technique will in large part be determined by the reason for the privatization itself. It should be pointed out, however, that the particular method of share distribution may actually result in a worse situation than that witnessed when the firm was a public entity. As an example, when the British Columbia Resources Investment Corporation (BCRIC) was turned over to the Provincial taxpayers, all investors were forbidden from holding more than 1 percent of BCRIC's shares except for mutual funds which were permitted to hold up to 3 percent. Any shareholder, moreover, holding 100 or more shares are allowed to vote at company meetings and as a result BCRIC has about 130,000 shareholders entitled to participate in its affairs. Control in the firm is even further diffused by the "associate member" rule which allows even a greater voice in the management of the company. This diffusion of ownership implies little self-motivation for any individual owner to become involved in the operations of the company, and hence, the market disciplining force usually present when a firm's stock is marketable, is absent in this case.

3. Courville (1974), Spann (1974), and Peterson (1974), for example, present findings that confirm the existence of an overcapitalization bias while Boyes (1976) and Fox (1975) reject the inefficiency thesis.

4. The interested reader is referred to Fama (1980) for an examination of the managerial labor market as the primary disciplinary force in both regulated and unregulated firms that induces managers to choose actions that are in the best interests of security holders. Fama's confidence in the labor market as a monitor is sufficiently strong so as to seriously question the need to implement other incentive mechanisms.

5. The interested reader is referred to Berkowitz and Cosgrove (1983) for an examination of the financing and investment decision of the regulated firm operating in an uncertain environment which includes the possibility of bankruptcy.

6. This reflects the control problem of the electoral system. While the issue of efficiency of electoral systems is outside the scope of this study, it is important to allow for deficiencies in it when analyzing the control of public corporations.

7. There may be other resources for government involvement and other objectives as well, perhaps secondary, which will also need to be taken into account when formulating the condition upon which to evaluate the performance of the manager. One way to accomplish this is to develop a multiple goal objective function where the various goals have different weights assigned by the decision-maker.

8. Refer to Section 2 for a discussion of these incentive schemes.

9. While the theoretical market portfolio consists of all risky assets in the market, for practical purposes, various surrogate market portfolios are used, e.g., TSE Index, Dow Jones Index, S & P Index, etc.

10. An excellent summary of the literature is presented in Hochman (1980). The original work was done by Beaver, Kettler and Scholes (1970). For an application to Crown corporations, see Berkowitz and Halpern (1981).

11. Commonly referred to as M-form. See Williamson (1975).

12. Assume, for example, that auditing prevent the manager from appropriating more than a proportion (δ) of cost increments, i.e., $U = s + \delta b - g(e)$. Then effort (e^{**}) is undertaken until $g' = \delta$, hence, marginal costs rise so $P(1+1/n) = (c \cdot e^{**}) > (c - e^{*})$.

13. This assumption is not strictly valid, as control mechanisms in private corporations are far from perfect. However, as argued elsewhere incentives tied to stock market performance are likely to lead to a significant correspondence of interest between shareholders and managers so managerial slack is likely to be relatively small.

14. This problem is present in the Sappington-Sibley mechanism even in the absence of managerial effort.

15. As well, it might attract risk lovers and those who overestimate their own ability. Basic screening processes are generally likely to eliminate the latter.

16. See Stiglitz and Weis (1983) and Jensen and Meckling (1976) for discussion of this problem.

17. It should be noted that satisfaction of inequality (5-13) is also sufficient to avoid making shirking the worker's best choice. To see this, we can write the condition for the worker not to choose to set his effort level at zero and collect m_2 as:

$$m_1 + kM + (1-k)m_2 - U(z_1^*) > m_1 + m_2 - U(0)$$

Measuring utility so that $U(0) = 0$. The above inequality can be rewritten as:

$$k(M-m_2) - U(z_1^*) > 0$$

which is clearly satisfied when inequality (5-13) holds.

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